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CLIMATE CHANGE ADAPTATION AND MITIGATION

Adaptation and mitigation are important strategies to address the global challenge of climate change. Adaptation involves actions to prepare for and adjust to both the current effects of climate change the predicted impacts. It includes implementation of resilient strategies and practices that reduce vulnerability and enhance the capacity to deal with climate-related risks. On the other hand, mitigation involves efforts to reduce greenhouse gas emissions. It includes actions like transitioning to clean energy sources, improving energy efficiency, and promoting sustainable practices.

IMPORTANT CONCEPTS

Carbon Sequestration

Carbon sequestration is the capturing, removal and storage of carbon dioxide from the earth's atmosphere. It is recognized as a key method for removing carbon from the earth's atmosphere. Carbon sequestration can be of three major types, i.e., terrestrial, geological and ocean carbon sequestration.

Terrestrial carbon sequestration

Terrestrial carbon sequestration refers to the mechanism by which carbon dioxide is taken in by trees and plants from the atmosphere. This absorption occurs during the process of photosynthesis and subsequently, the carbon is stored in the form of biomass (such as tree trunks, branches, foliage, and roots) and soils. Through the natural process of photosynthesis, trees and plants convert carbon dioxide into organic matter, effectively sequestering carbon from the atmosphere.

Geological carbon sequestration

Carbon dioxide has the potential to be stored in various types of geological formations. These formations include oil reservoirs, gas reservoirs, unmendable coal seams, saline formations, and shale formations rich in organic content. These geological formations provide potential storage sites for carbon dioxide, preventing its release into the atmosphere.

Ocean carbon sequestration

The absorption, release, and storage of substantial quantities of carbon dioxide from the atmosphere are carried out by oceans. There are two methods to achieve this: enhancing the productivity of ocean biological systems through Iron fertilization and injecting carbon dioxide into the deep ocean.

- **Iron fertilization:** It involves the dumping of iron, which stimulates the production of phytoplankton. The increased presence of phytoplankton leads to enhanced photosynthesis by these microorganisms, aiding in the absorption of carbon dioxide.
- **Injecting carbon dioxide:** This technique involves deliberately introducing carbon dioxide, into the deep ocean layers.

Benefits of Carbon Sequestration

- According to the IPCC report, planting trees and managing their growth is a valuable strategy in achieving **Net Zero Emission by 2050.**
- By reducing the amount of carbon in the atmosphere, the greenhouse effect can be lessened, which mitigate the impact of climate change.
- Planting trees and managing their development is a proven way to reduce the number of harmful particulates in the air.

DO YOU KNOW?

Oil India Limited (OIL) signed an MoU with Assam Forest Department for a project on Carbon Sequestration and Restoration of Degraded Forest Land in Upper Dihing Reserved Forest. The initiative has been undertaken under OIL's CSR project Vasundhara. Under the project, reforestation, and afforestation in 100 hectares of degraded forest area is planned to be undertaken through plantation of 2,50,000 saplings by March 2025.

Carbon Sink

Carbon sinks are natural or artificial reservoirs that absorb and store carbon dioxide from the atmosphere, thus helping to mitigate the impacts of climate change. They play a crucial role in the carbon cycle by balancing the amount of carbon dioxide released into the atmosphere through various sources. There are several types of carbon sinks, including: Forest Carbon Sink, Ocean Carbon Sink, Soil Carbon Sink, Wetland Carbon Sink.

Forest as carbon sink

Forests, including tropical rainforests, temperate forests, and boreal forests, are among the most significant natural carbon sinks. Trees absorb carbon dioxide during photosynthesis and store carbon in their biomass (trunks, branches, leaves) and in the soil. This makes intact and healthy forests vital for sequestering carbon. Forests can act as both carbon sources and carbon sinks.

Forests as carbon sources	Forests as carbon sink
A forest is considered to be a carbon source if it releases more carbon than it absorbs. Forest carbon is released when trees burn or when they decay after dying (as a result of old age or of fire, insect attack or other disturbance).	A forest is considered to be a carbon sink if it absorbs more carbon from the atmosphere than it releases. Carbon is absorbed from the atmosphere through photosynthesis. It then becomes deposited in forest biomass (that is, trunks, branches, roots and leaves), in dead organic matter (litter and dead wood) and in soils. This process of carbon absorption and deposition is known as carbon sequestration.

Ocean as carbon sink

The world's oceans are large carbon sinks. They absorb carbon dioxide from the atmosphere through a process called ocean uptake or carbon sequestration. Surface waters take up carbon, and it is transported to the deep ocean through various processes. The oceans contain more carbon dioxide than the atmosphere and there is an exchange of carbon dioxide between the two. The ocean absorbs approximately 25% of the carbon dioxide released into the atmosphere each year. As atmospheric carbon dioxide levels increase, so do the ocean's carbon dioxide levels. However, the carbon dioxide in the ocean does not trap heat as it does in the atmosphere.

Soil as carbon sink

Soils store significant amounts of carbon through the decomposition of organic matter. Practices such as sustainable agriculture, agroforestry, and reforestation enhance carbon sequestration in soils. Healthy soil management, including minimizing tillage, maintaining organic matter, and promoting cover crops, help increase carbon storage.

The long-term conversion of grassland and forest land to cropland (and grazing lands) has resulted in historic losses of soil carbon worldwide, but there is a major potential for increasing soil carbon through restoration of degraded soils and widespread adoption of soil conservation practices.

- FAO has estimated that soils, mostly agricultural ones could sequester over a billion additional tons of carbon each year. This has led policymakers to increasingly look to soil-based carbon sequestration as a "negative emissions" technology—that is, one that removes carbon dioxide from the air and stores it somewhere it can't easily escape.
- Cropland, which makes up 10% of the Earth's land, is a major target for soil-based carbon sequestration. Farmers can add more carbon to agricultural soils by planting certain kinds of crops. For instance, perennial crops, which do not die off every year, grow deep roots that help soils store more carbon.
- "Cover crops" like clover, beans and peas, planted after the main crop is harvested, help soils take in carbon year-round, and can be ploughed under the ground as "green manure" that adds more carbon to the soil.

Wetland as carbon sink

Wetlands, including marshes, swamps, and bogs, are carbon-rich ecosystems. They act as effective carbon sinks by trapping and storing large amounts of organic matter in their soil. Wetlands also have the capacity to remove carbon dioxide from the atmosphere through photosynthesis by aquatic plants.

- Wetland plants absorb carbon dioxide as they grow, and when they die, that carbon doesn't get released back into the atmosphere. Instead, the plant sinks to the bottom of the wetland where it can't fully decompose.
- Carbon is held in the living vegetation as well as in litter, peats, organic soils, and sediments that have built up, in some instances, over thousands of years.

- Over time, carbon accumulates in partially decomposed plant matter at the bottom of wetlands, and this carbon is stored for hundreds or even thousands of years. Wetland soils are anoxic (oxygen-poor), and therefore slow decomposition and lead to the accumulation of organic matter.
- The magnitude of storage depends upon wetland type and size, vegetation, the depth of wetland soils, groundwater and nutrient levels, pH, and other factors.
- Wetland soils also store carbon that washes in from upland areas, through soil erosion or movement of leaves and tree debris. Wetlands also release carbon both through natural, seasonal changes.

IMPORTANT MITIGATION STRATEGIES

Carbon Capture and Storage (CCS)

Carbon capture and storage involves the capture of carbon dioxide emissions from industrial processes, such as steel and cement production, or from the burning of fossil fuels in power generation. This carbon is then transported from where it was produced, via ship or in a pipeline, and stored deep underground in geological formations.

- **Objective:** The goal of Carbon capture storage is to reduce the amount of greenhouse gases that are emitted into the atmosphere and mitigate climate change.
- **Process:** The storage phase of Carbon capture storage involves injecting the carbon dioxide into a geological formation, such as a deep saline aquifer or depleted oil and gas reservoirs. The carbon dioxide is stored under pressure in these formations, which prevents it from escaping into the atmosphere. Over time, the carbon dioxide dissolves and is trapped in the geological formation, effectively removing it from the atmosphere.
- **Types of Carbon Capture and Storage Technologies:**
    - **Chemical Solvent-based**: It is preferred when dealing with gas streams that are lean in CO2 and have relatively lower pressures such as flue gas streams for power plants.
    - **Physical solvent based**: These work on gas streams with relatively higher CO2 concentration and pressure, such as gasification projects.
    - **Adsorption based:** These are suitable for gas streams with moderate to high pressure and moderate CO2 concentration such as SMR flue gas or BF gas (Blast furnace gas)
    - **Cryogenic:** These are preferred in cases where the cost of power is low. It can be applied for carbon capture from the PSA tail gas of steam methane reforming units.
- **Prevention of global warming by Carbon capture storage:** The IPCC emphasized that employing carbon removal technologies, such as carbon capture storage, is crucial for limiting temperature rises to 1.5°C and addressing global warming effectively.
- **Disadvantage:** While Carbon capture storage has the potential to significantly reduce greenhouse gas emissions, there are some challenges associated with the technology. These include the high cost of capture and storage, the need for large-scale infrastructure, and concerns about the safety and long-term stability of storage sites.
- **Current landscape of CCS technologies**

Global	India
• Globally there are about 21 CCUS facilities, with a capacity of capturing only 0.1% of the 40 gtpa global annual GHG emissions.	• Presently carbon capture in India is confined to certain industries where the carbon capture is part of the process, viz., the manufacture of urea.
• The first CCUS projects started in the 1970s and 1980s in Texas for capturing CO2 from natural gas processing plants. Since then, CCUS has spread to other countries, viz. Norway, Canada, Australia, Brazil, Canada, China, Saudi Arabia and the United Arab Emirates.	• CO2 is also captured as part of the gas conditioning process in the gasifiers, but the captured CO2 is largely released to the atmosphere and not utilized or stored. • However, there are no commercial-scale dedicated CCUS projects in India.

Carbon Capture, Utilization and Storage (CCUS)

Carbon Capture Utilization and Storage refers to the idea that, instead of storing carbon, it could be re-used in industrial processes and can be converted to value-added products. Example: Green urea can be produced from the captured CO2 and green hydrogen, from renewable energy-based electrolysis of water.

NITI Aayog has released a study report, titled '**Carbon Capture, Utilization, and Storage (CCUS) Policy Framework and its Deployment Mechanism** in India'. The report examines the significance of CCUS as a strategy for reducing emissions and achieving deep decarbonization in the hard-to-abate sectors. It highlights the range of policy interventions required across different sectors to facilitate its implementation.

Geoengineering to Fight Climate Change

Geoengineering refers to deliberate, large-scale interventions in the Earth's climate system to mitigate the impacts of climate change. These interventions aim to either remove greenhouse gases from the atmosphere or reduce the amount of sunlight reaching the Earth's surface. Though geoengineering approaches have been proposed, they come with potential risks and uncertainties.

Solar Radiation Management (SRM) or Solar Geoengineering

Solar Radiation Management (SRM) is a type of geoengineering that involves reflecting sunlight back into space or reducing the amount of solar radiation that reaches the Earth's surface. The goal of SRM is to reduce the amount of solar radiation absorbed by the Earth, thereby cooling the planet and mitigating the impacts of climate change.

Methods adopted for Solar Radiation Management

- **Stratospheric Aerosol Injection (SAI):** The method involves injecting tiny reflective particles, such as sulfur dioxide, into the upper atmosphere to reflect sunlight back into space.
- **Space-based mirrors & Ocean mirror:** The method involves placing mirrors or other reflective surfaces in space to reflect sunlight away from the Earth. The reflectance of ocean foam can be more than ten times higher than the ocean itself and the ocean occupies 71% of our planet's surface so enhancing sea foam is a sensible and simple way to reflect a few percent more sunlight.
- **Cloud brightening:** This involves increasing the reflectivity of clouds by spraying seawater or other substances into the atmosphere to increase the number of cloud droplets.
- **High-albedo crops and buildings:** The idea of increasing the albedo of buildings in order to reflect more sunlight. Put simply, this would involve making rooftops and walls brighter by painting them white.
- **Cloud thinning:** Another less-explored option for reducing the effects of sunlight at the Earth's surface is to "remove" cirrus clouds from the atmosphere. Cirrus clouds are thin, wispy clouds made of ice crystals, which form at high altitudes. The clouds reflect away some sunlight, but also absorb large amounts of long-wave radiation meaning that, on balance, they warm the planet.

- **Artificial snow (snow albedo modification):** Artificial snow has been proposed as a potential strategy to mitigate the impacts of climate change by increasing the reflectivity of snow and ice, which can help to cool the planet. This approach is known as "snow albedo modification" or "solar radiation management" (SRM). The idea behind snow albedo modification is that by increasing the reflectivity of snow and ice, more sunlight is reflected back into space, reducing the amount of solar radiation that is absorbed by the Earth's surface and atmosphere. This, in turn, could help to cool the planet and mitigate the impacts of global warming. There are several proposed methods for implementing snow albedo modification, including:
    - Spraying reflective particles onto snow and ice: This method involves spraying reflective particles, such as titanium dioxide or calcium carbonate, onto snow and ice surfaces to increase their reflectivity.
    - Covering snow and ice with reflective materials: Another approach involves covering snow and ice with reflective materials, such as reflective blankets or sheets, to increase their reflectivity.

Potential risks involved in Solar Radiation Management (SRM)

While SRM has the potential to cool the planet and mitigate the effects of climate change, there are also significant risks and uncertainties associated with the technology. For instance, SRM could have unintended consequences, such as altering regional weather patterns or damaging the ozone layer. Additionally, SRM does not address the root causes of climate change, such as the burning of fossil fuels, and could potentially be used as a "quick fix" that distracts from the need for more comprehensive and sustainable solutions. SRM should only be considered as a last resort if other efforts to mitigate climate change fail.

Greenhouse Gas Removal (GGR) or Carbon Geoengineering

Greenhouse Gas Removal (GGR) or Carbon Geoengineering is a set of technologies and approaches aimed at removing carbon dioxide and other greenhouse gases (GHGs) from the atmosphere in order to mitigate the impacts of climate change.

Methods adopted for Greenhouse Gas Removal

- **Afforestation and reforestation:** Planting trees and other vegetation to remove carbon dioxide from the atmosphere and store it in biomass.
- **Soil carbon sequestration:** Managing soil to enhance the storage of carbon, for example through practices like no-till farming or adding biochar to soil.
- **Bioenergy with carbon capture and storage (BECCS):** Generating energy from biomass, and then capturing and storing the carbon dioxide emissions from the process.
- **Direct air capture (DAC):** Removing carbon dioxide directly from the atmosphere using specialized equipment, and then storing it in underground reservoirs or using it for other purposes.
- **Ocean fertilization:** Adding nutrients to the ocean to stimulate the growth of phytoplankton, which absorb carbon dioxide from the atmosphere and store it in their biomass.

Carbon Pricing

Carbon pricing is a market-based mechanism used to reduce greenhouse gas (GHG) emissions. It works by **putting a price on carbon emissions**, either through a carbon tax or an emission trading system, in order to create an economic incentive for individuals and businesses to reduce their carbon footprint.

Need for carbon pricing:

- **Climate change mitigation:** Carbon pricing supports climate change mitigation efforts by encouraging individuals and businesses to reduce their carbon footprint.
    - **Eg: British Columbia** implemented a **carbon tax in 2008,** which has since been credited with reducing the **province's greenhouse gas emissions by 5-15%.** The tax has incentivized individuals and businesses to reduce their carbon footprint by switching to cleaner energy sources and adopting energy-efficient practices.
- **Revenue generation:** Carbon pricing can generate revenue for environmental programs that promote sustainable practices and research into new technologies.
    - **Eg: In British Columbia**, the revenue-neutral carbon tax of CAD 10 per ton of CO2, was gradually increased to CAD 30 per ton by 2012.
    - The revenue generated from the tax was returned to taxpayers through reductions in other taxes, such as personal and corporate income taxes.
    - This helped to support sustainable practices and research **into new technologies, such as renewable energy,** while also creating a shift towards a low-carbon economy.

- **Encouraging Sustainable Business Practices:** Carbon pricing can encourage sustainable business practices by making them more cost-effective than environmentally harmful practices.
  - **Eg:** One example of a country that has successfully encouraged sustainable business practices through **carbon pricing is Sweden.**
  - The country has had a carbon tax since the early 1990s, which has helped to drive down emissions while also generating revenue for sustainable programs and technologies.
  - This has encouraged businesses to invest in sustainable practices and technologies to reduce their carbon footprint and avoid paying the tax.

Types of Carbon Pricing Mechanism

- **Carbon tax:** A carbon tax is a direct tax on the carbon content of fossil fuels. It is designed to increase the cost of fossil fuels, thereby incentivizing consumers to switch to cleaner alternatives. A carbon tax can be applied to a wide range of emissions sources, including electricity generation, transportation, and industrial processes.
- **Emissions trading system:** An emissions trading system (ETS) is a market-based mechanism that sets a cap on the total amount of greenhouse gases that can be emitted by covered entities such as power plants, factories, and airlines. Companies are then allocated permits that allow them to emit a certain amount of greenhouse gases. Companies that emit less than their allowance can sell their unused permits to companies that exceed their limit. This creates a market for emissions allowances and provides an economic incentive for companies to reduce their emissions.
- **Import tariffs/Carbon Border Tax:** Import tariffs are taxes imposed on goods imported from countries that do not have a carbon pricing policy. This is intended to level the playing field between domestic producers who are subject to carbon pricing and foreign producers who are not. The goal is to discourage the import of goods that are carbon-intensive and incentivize the production of low-carbon products domestically.
- **Offset Mechanism:** It is usually project or program based, which offers carbon credits to entities in accordance with an accounting protocol or their own registry.
- **Result**-based Climate Finance: It makes payments to programs which are verified to have climate change mitigating outcomes, such as emission reductions.
- **Internal Carbon Pricing:** Organizations usually use internal carbon pricing to direct their decision-making process related to the effects, risks and opportunities of climate change.

Carbon Border Adjustment Mechanism (CBAM):

It was proposed by EU in 2021. It was designed in compliance with World Trade Organization (WTO) rules and EU's other international obligations.

- **Aim:** To address carbon leakage- a situation where a company decides to move their production from a country with stringent policies, to a country that is more lenient, leading to an increase in greenhouse gas emissions.
- Under CBAM, EU importers need to buy carbon certificates based on the carbon price that would have been paid, had the goods been produced under the EU's carbon pricing rules.
- It will be imposed on imported goods such as iron and steel, cement, aluminum, fertilizers, electricity, and hydrogen, applicable from October 1, 2023.

Landscape of Carbon Pricing across the Globe:

Carbon pricing has become an increasingly popular policy tool for addressing climate change around the world. As of 2021, over 60 carbon pricing schemes are in operation or scheduled for implementation in 46 countries and regions. Some prominent examples of carbon pricing policies from around the world:

- **European Union Emissions Trading System (EU ETS):** This is the world's largest carbon pricing system. It operates on a cap-and-trade system, with the cap declining over time.
- **China's Emission Trading Scheme:** China introduced its first national carbon market in 2021, which covers the power sector and is expected to expand to other industries.
- **California's Cap-and-Trade Program:** This program covers around 450 businesses in California and has been successful in reducing emissions while generating revenue for the state. It operates on a cap-and-trade system, with the cap declining over time.
- **South Korea's Emission Trading Scheme:** This scheme covers around 600 businesses and is the second-largest carbon pricing scheme in the world. It operates on a cap-and-trade system, with the cap declining over time.

Limitations of Carbon Pricing:

- **Impact on Low-Income Households:** Carbon pricing can have a regressive impact on low-income households, as they may spend a larger portion of their income on energy and other goods and services that are subject to carbon pricing.
- **Impact on Industries:** Carbon pricing can also have a negative impact on industries that are heavily reliant on carbon-intensive processes, such as the oil and gas industry.
- **Difficulty in Implementing:** Implementing carbon pricing can be difficult, as it requires a complex regulatory framework and monitoring system to ensure compliance.
- **Limited Scope:** Carbon pricing alone may not be sufficient to achieve the necessary emissions reductions to combat climate change.
- **Carbon Leakage:** Carbon pricing in one country or region can lead to carbon leakage, where emissions-intensive industries move to countries or regions with weaker carbon pricing or regulatory systems, resulting in no overall reduction in global emissions.
- **Political Opposition:** Carbon pricing can be a controversial policy measure, and it may face opposition from industry groups, politicians, and the public who are concerned about its impact on the economy or personal finances.

Carbon Markets

Carbon Market is a tool for putting a price on carbon emissions. They establish trading systems where carbon credits or allowances can be bought and sold.

- **Carbon Credit:** It is a kind of tradable permit that, per United Nations standards, equals one tonne of carbon dioxide removed, reduced, or sequestered from the atmosphere.
- **Carbon Allowances:** They are determined by countries or governments according to their emission reduction targets.

Types of carbon Markets

Compliance markets	Voluntary markets
• Under it, policies set up at the national, regional, and/or international level— are officially regulated. • Entities in this sector are issued annual allowances or permits by governments equal to the emissions they can generate. • If companies produce emissions beyond the capped amount, they have to purchase additional permit. • This makes up the 'trade' part of cap-and-trade. • The market price of carbon gets determined by market forces when purchasers and sellers trade in emissions allowances. • Companies can also save up excess permits to use later.	• They are those in which emitters— corporations, private individuals, and others— buy carbon credits to offset the emission of one ton of carbon dioxide or equivalent greenhouse gases. • Such carbon credits are created by activities which reduce carbon dioxide from the air, such as afforestation. • In a voluntary market, a corporation looking to compensate for its unavoidable GHG emissions purchases carbon credits from an entity engaged in projects that reduce, remove, capture, or avoid emissions.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The UNFCCC is an international environment treaty to address climate change. It sets out the basic legal framework and principles for international climate change cooperation

- **Background:** The UNFCCC was introduced during the United Nations Conference on Environment and Development (UNCED), popularly known as the Earth Summit held in Rio de Janeiro in 1992. The UNFCCC entered into force on 21st March, 1994.
- **Membership:** The Convention has been ratified by 197 states, including India.
- **Objective:** Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
    - The objective must be achieved within an adequate time frame.
    - Sufficient time is required to allow ecosystems to naturally adapt to climate change.
    - The timeframe should ensure that the food supply is not put at risk.

- It should also enable sustainable economic development to progress.

- **UNFCCC Secretariat (UN Climate Change):** It is based in Bonn, Germany. It provides organizational support and technical expertise to the UNFCCC negotiations and institutions and facilitates the flow of authoritative information on the implementation of the Convention, the Kyoto Protocol and the Paris Agreement. A key task of the secretariats is to organize annual COPs. Other functions include helping governments report data and to organize technical workshops.

Key Features

- It recognizes the **principle of common but differentiated responsibility (CBDR)** and respective capability. This means different states have different capabilities and responsibilities to address climate change.
- It sets out the basic legal framework and principles for international climate change cooperation
- **Conference of Parties (COP)**- It is the supreme decision-making body of the UNFCC. UN climate change conferences are the official meetings of the Conference of the Parties.
- **Entities entrusted with the operations of the Financial Mechanism** are: the Global Environment Facility (GEF) and the Green Climate Fund (GCF).
- The Convention divides countries into three main groups according to differing commitments:

Annex I Parties	Annex II Parties	Non-Annex I Parties
1) It includes the industrialized countries that were members of the OECD (Organization for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties).	1) It consists of the OECD members of Annex I, but not the EIT Parties.	1) They are mostly developing countries.
2) The EIT parties includes the Russian Federation, the Baltic States, and several Central and Eastern European States.	2) They are required to provide financial resources to enable developing countries to undertake emissions reduction activities.	2) Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change (including countries with low-lying coastal areas and those prone to desertification and drought).
	3) In addition, they have to "take all practicable steps" to promote the development and transfer of environmentally friendly technologies to EIT Parties and developing countries.	3) The 46 Parties classified as least developed countries (LDCs) by the United Nations are given special consideration under the Convention on account of their limited capacity to respond to climate change and adapt to its adverse effects.
	4) Funding provided by Annex II Parties is channeled mostly through the Convention's financial mechanism.	

Important Milestones under UNFCCC

COP-3, Kyoto, 1997 (Kyoto Protocol)

Background: The Kyoto Protocol was adopted at the COP-3 conference in Kyoto, Japan, in 1997 and entered into force in 2005.

Membership: There are 192 Parties to the Kyoto Protocol.

Key Features

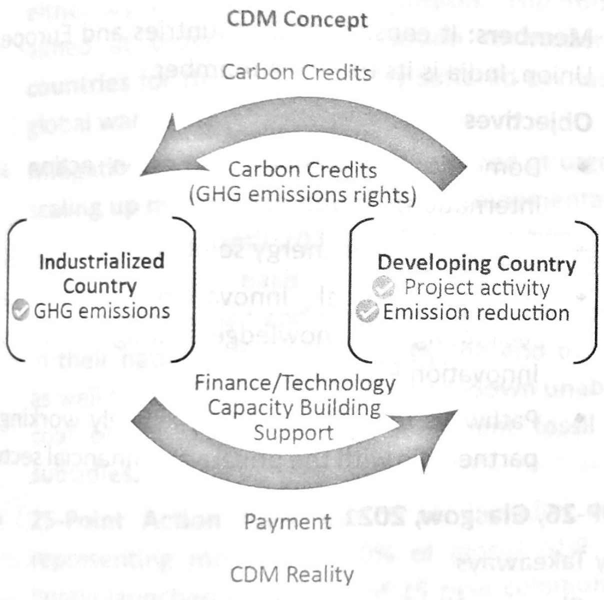
- The Kyoto Protocol operationalizes the UNFCC by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets.
- It only binds developed countries, and places a heavier burden on them under the principle of "common but differentiated responsibility and respective capabilities".

Market-based Mechanisms under Kyoto Protocol

Under the Protocol, countries must meet their targets primarily through national measures. However, the Protocol also offers them an additional means to meet their targets by way of three market-based mechanisms namely, International Emissions Trading, Clean Development Mechanism (CDM), Joint implementation (JI)

- **International Emissions Trading:**
  - It refers to a system that allows countries to trade emissions allowances, or permits to emit a certain amount of greenhouse gases. The main objective is to reduce emissions and achieve their emissions reduction targets. It is based on the cap-and-trade concept.
  - Example: European Union Emissions Trading System (EU ETS), which is the world's largest emissions trading system.

- **Clean Development Mechanism (CDM):**
  - The CDM allows developed countries with a commitment under the Kyoto Protocol (known as "Annex B Parties") to earn emissions credits (Certified Emission Reductions, or CERs) by investing in emissions-reducing projects in developing countries. where the cost of reducing emissions may be lower.
  - In turn, the host country (developing country) can receive investment, technology transfer, and other benefits from the CDM project.
  - Examples of CDM projects include renewable energy projects such as wind farms, hydroelectric power plants, and solar power plants, as well as energy efficiency and fuel switch projects in industry and transportation.



CDM = clean development mechanism, GHG = greenhouse gas.

CDM Concept

- **Joint Implementation:**
  - It works similarly to CDM, with the exception that the host country is not a low and middle-income nation but another Annex I (developed) country.
  - The tradable units from JI projects are called Emissions Reductions Units (ERUs).

COP-13, Bali, 2007 (Bali Action Plan)

- The Bali Road map was adopted which included the Bali Action Plan.
- Countries collectively accepted the need for "deep cuts" in greenhouse gas emissions and agreed to long-term cooperative action, up to and beyond 2012.
- Adaptation Fund was adopted.

COP-15, Copenhagen, 2009

- It marked the end of the Bali Road Map and resulted in the drafting of the **Copenhagen Accord** by USA and the BASIC countries
- The Accord declared that global warming should be limited to 2°C.
- It was not legally binding and commitments made under the Accord were voluntary.

COP-16, Cancún, 2010 (Cancun Agreements)

- The Cancun agreement recognized that Annex A parties' GHG emissions are to be reduced by 25% to 40% below 1990 levels by 2020, in order to control the global warming at 2 degrees C or less
- Green Climate Fund (GCF) was established.
- Technology Mechanism was established-It aims to facilitate enhanced action on technology development and transfer to support action on mitigation and adaptation.

COP-21, Paris, 2015 (Paris Agreement)

The Paris Agreement is legally binding international treaty on climate change. It provides a framework for financial, technical and capacity building support to those countries who need it.

- **Background:** Negotiations for the Paris Agreement started in Durban, South Africa at the COP17 with the establishment of the Ad Hoc Working Group on the Durban Platform for Enhanced Action, commonly known as the Durban Platform. It was adopted by 196 Parties at COP 21 in Paris, in 2015 and entered into force in 2016.
- **Long-term goals of the Paris Agreement:**

1. to hold the increase in global average temperature to well below 2°C,
2. to pursue efforts to limit the increase to 1.5°C, and
3. to achieve net zero emissions in the second half of this century.

- **Nationally Determined Contributions (NDC)**
  - It is a plan submitted by countries to work towards their climate goals.
  - Signatories of Paris Climate Agreement must prepare, communicate, and maintain the NDCs it intends to achieve as part of its climate action plan.
  - Countries are required to submit NDCs every five years to the UNFCCC secretariat.

Long-Term Strategies:

- ◆ The Paris Agreement invites countries to formulate and submit by 2020 long-term low greenhouse gas emission development strategies (LT-LEDS).
- ◆ LT-LEDS provide the long-term horizon to the NDCs.
- ◆ In contrary to the NDCs, they are not mandatory. They place the NDCs into the context of countries' long-term planning and development priorities, providing a vision and direction for future development.

- **Enhanced Transparency Framework (ETF).:**
    - ◆ With the Paris Agreement, countries established an enhanced transparency framework (ETF).
    - ◆ As part of the ETF, all countries who have ratified the Paris Agreement will follow a single, universal transparency process.
    - ◆ Under the ETF (starting in 2024), countries will report transparently on actions taken and progress in climate change mitigation, adaptation measures and support provided or received
    - ◆ It also provides for international procedures for the review of the submitted reports. The information gathered through the ETF will feed into the Global stocktake
    - ◆ The rules to operationalize the ETF, referred to as the modalities, procedures and guidelines (MPGs), were agreed by countries in **Katowice, 2018 (COP 24).**
- **The global stocktake:**
    - ◆ The global stocktake is a periodic assessment of the collective efforts of Parties to the Paris Agreement to address climate change.
    - ◆ The first global stocktake will take place in 2023 and will occur every five years thereafter.
    - ◆ During the global stocktake, Parties will review progress towards their Nationally Determined Contributions (NDCs), which are the commitments they have made to reduce their greenhouse gas emissions, and will assess their efforts to increase ambition and improve their NDCs.
    - ◆ The outcome of the stocktake will inform the Parties in enhancing their efforts and taking action to achieve the goals of the Paris Agreement.

Carbon Neutral: It means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Palli in Jammu and Kashmir's border district of Samba is India's first carbon-neutral panchayat.

Net Zero: It means that an activity releases net-zero carbons emissions into the atmosphere.

In order to achieve net zero emissions, all worldwide greenhouse gas (GHG) emissions will have to be counterbalanced by carbon sequestration- the process of capturing and storing atmospheric carbon dioxide

Mission Innovation

It was announced at **COP21 Paris Agreement of UNFCCC** on November 30, 2015.It is a global initiative catalyzing a decade of action and investment in research, development and demonstration to make clean energy affordable, attractive and accessible for all.

- **Members:** It consists of 22 countries and European Union. India is its founding member.
- **Objectives**
    - ◆ Domestic investment, innovation action and international cooperation.
    - ◆ Catalyzing clean energy solutions for all
    - ◆ Analyzing global innovation progress and facilitating knowledge-sharing through Innovation Platform.
    - ◆ Pathways to deployment by actively working in partnership with the private and financial sectors

COP-26, Glasgow, 2021

Key Takeaways

- **Glasgow Climate Pact**: It aims to restrict harmful emissions to limit global warming to 1.5 degrees above pre-industrial levels.
- **Global Methane Pledge**: It aims to limit methane emissions by 30 per cent by 2030, compared to 2020 levels.
- **Beyond Oil and Gas Alliance**: Led by Costa Rica and Denmark, it pledged to end new licensing rounds for oil and gas exploration and production and set an end date that is aligned with Paris Agreement objectives.
- **Solar Investment Action Agenda**: Launched by WRI, the International Solar Alliance (ISA) and Bloomberg Philanthropies, it identifies high-impact opportunities to speed up investment and reach ISA's goal of mobilizing $1 trillion in solar investment by 2030.

DO YOU KNOW?

First Movers Coalition Steering Board

India joined the First Movers Coalition Steering Board

Launched by: USA and World Economic Forum (WEF) at COP26 in Glasgow, Scotland.

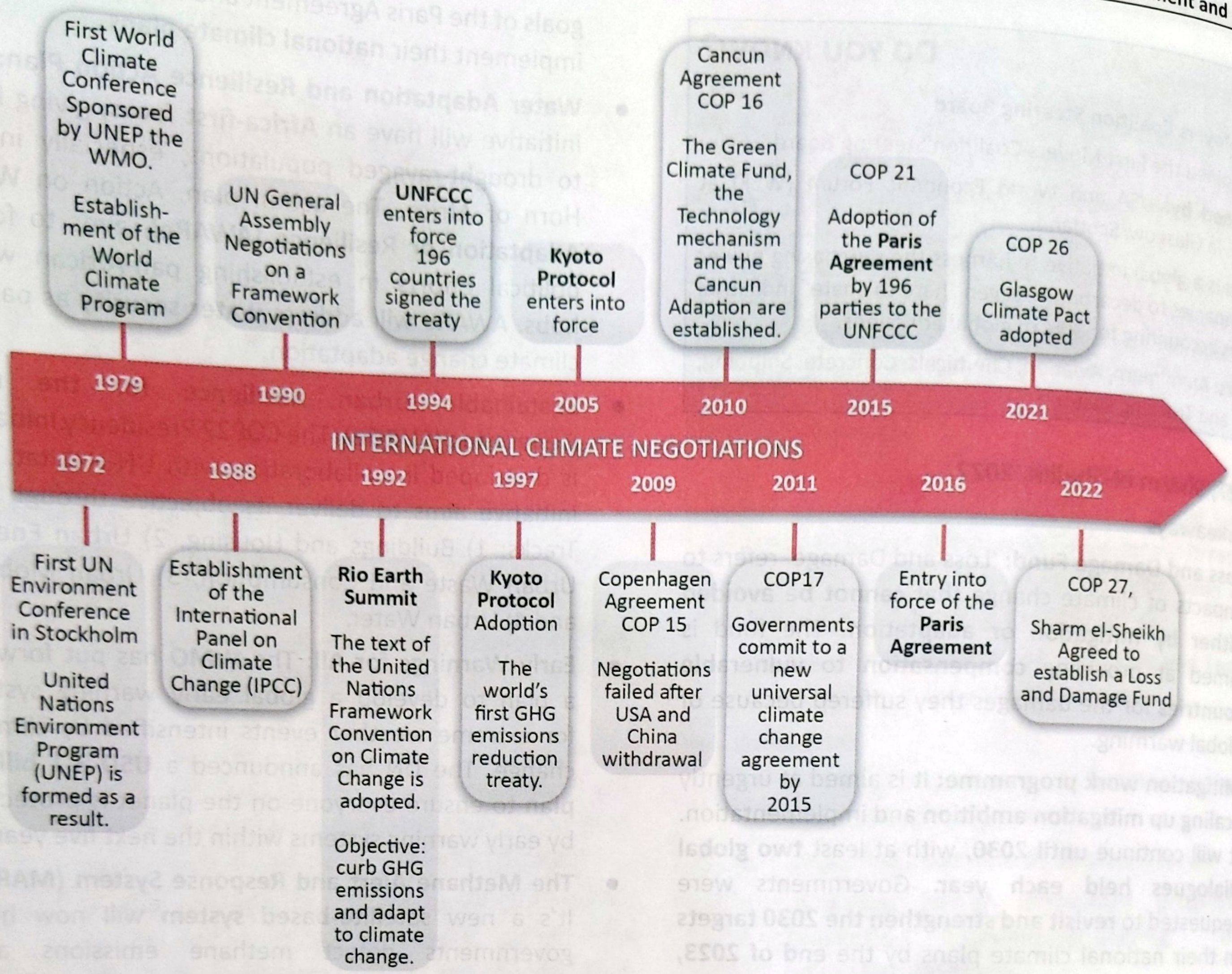
Aim: It is a global initiative to harness the purchasing power of companies to decarbonize seven "hard to abate" industrial sectors accounting for 30% of global emissions.

Sectors: Aluminium, Aviation, Chemicals, Concrete, Shipping, Steel, and Trucking sector

COP-27, Sharm el-Sheikh, 2022

Key Takeaways

- **Loss and Damage Fund:** 'Loss and Damage' refers to impacts of climate change that **cannot be avoided either by mitigation or adaptation.** The fund is aimed at providing **compensation to vulnerable countries** for the damages they suffered because of global warming.
- **Mitigation work programme:** It is aimed at urgently **scaling up mitigation ambition** and implementation. It will continue **until 2030,** with at least **two global dialogues held each year.** Governments were requested to **revisit and strengthen the 2030 targets** in their national climate plans by the **end of 2023,** as well as accelerate efforts to **phasedown unabated coal power** and phase-out inefficient **fossil fuel subsidies.**
- **25-Point Action Plan:** Countries, including India, representing more than 50% of global GDP have jointly launched a package of **25 new collaborative actions** to be delivered by COP 28. The plan is aimed at the **decarbonization of five key sectors:** power, road transport, steel, hydrogen and agriculture. (These sectors collectively account for more than 50% of the global GHG emission).
- **Sharm el-Sheikh Adaptation Agenda:** It outlines **30 goals** to enhance resilience for **4 billion people** living in the most climate vulnerable communities by **2030.** It seeks to mobilize **$140 billion to $300 billion** across both public and private sources annually to pursue these goals which include transitioning to climate resilient and **sustainable agriculture, nature-based solutions** etc.
- **Technology Mechanism Work Programme:** It's a **five-year (2023-27)** work program to promote **climate technology solutions** in developing countries in order to support countries' efforts in achieving the goals of the Paris Agreement and the UNFCCC, and to implement their **national climate plans.**
- **Water Adaptation and Resilience Action Plan:** The initiative will have an **Africa-first focus,** giving hope to drought-ravaged populations, especially in the Horn of Africa. The action plan, Action on **Water Adaptation or Resilience (AWARe),** aims to foster political efforts in establishing pan-African water hubs. AWARe will address **water security** as part of climate change adaptation.
- **Sustainable Urban Resilience for the next Generation (SURGe):** The COP27 Presidency Initiative is developed in collaboration with UN-Habitat. The initiative aims to deliver its objective through five Tracks: 1) Buildings and Housing, 2) Urban Energy, Urban Waste and Consumption, 3) Urban Mobility and 4) Urban Water.
- **Early Warnings for All:** The **WMO** has put forward a plan to develop a global early warning system for extreme weather events intensified by climate change. The UN has announced a **USD 3.1 billion plan** to ensure everyone on the planet is protected by early warning systems within the next five years.
- **The Methane Alert and Response System (MARS):** It's a new **satellite-based system** will now help governments detect methane emissions and tackle them. It was launched as part of the UNEP's **International Methane Emissions Observatory (IMEO) strategy** to get policy-relevant data into the right hands for emissions mitigation.
- **Global Shield Fund:** It is a joint initiative of the **G7 and the V20 Group** of 20 vulnerable countries, launched at the COP 27. It aims to provide **rapid access for climate-vulnerable countries** to insurance and disaster protection funding after floods or drought.
- **Mangrove Alliance for Climate:** It aims to scale up and accelerate the conservation and restoration of the mangrove forests. Members: India, UAE, Indonesia, Australia, Japan, Spain and Sri Lanka. The alliance is spearheaded by the UAE in partnership with Indonesia.
- **"In our LiFEtime" Campaign:** Launched by National Museum of Natural History (NMNH), under the Ministry of Environment Forest and Climate Change and United Nations Development Programme (UNDP). It seeks to encourage youth between the ages of 18 to 23 years to become message bearers of sustainable lifestyles.


First World Climate Conference Sponsored by UNEP the WMO.
Establish-ment of the World Climate Program
UN General Assembly Negotiations on a Framework Convention
UNFCCC enters into force 196 countries signed the treaty
Kyoto Protocol enters into force
Cancun Agreement COP 16
The Green Climate Fund, the Technology mechanism and the Cancun Adaption are established.
COP 21
Adoption of the Paris Agreement by 196 parties to the UNFCCC
COP 26
Glasgow Climate Pact adopted
1979
1990
1994
2005
2010
2015
2021
INTERNATIONAL CLIMATE NEGOTIATIONS
1972
1988
1992
1997
2009
2011
2016
2022
First UN Environment Conference in Stockholm
United Nations Environment Program (UNEP) is formed as a result.
Establishment of the International Panel on Climate Change (IPCC)
Rio Earth Summit
The text of the United Nations Framework Convention on Climate Change is adopted.
Objective: curb GHG emissions and adapt to climate change.
Kyoto Protocol Adoption
The world's first GHG emissions reduction treaty.
Copenhagen Agreement COP 15
Negotiations failed after USA and China withdrawal
COP17
Governments commit to a new universal climate change agreement by 2015
Entry into force of the Paris Agreement
COP 27,
Sharm el-Sheikh Agreed to establish a Loss and Damage Fund

International Climate Negotiations

Major Economies Forum (MEF) on Climate and Energy

The initiative was introduced in 2009 by the US President, with the aim of encouraging discussions among significant emitting countries, both developed and developing, to enhance efforts against climate change. Major countries like Australia, Brazil, Canada, China, the European Union, France, Germany, India, Japan, the United Kingdom, among others, have actively participated in this initiative,

The initiative has introduced several initiatives, highlighting their commitment to addressing various aspects of climate change and promoting sustainability. These initiatives encompass a range of sectors and focus on reducing emissions, enhancing energy efficiency, and improving food security.

- **Global Methane Pledge Energy Pathway:**
  - **Aim:** The Global Methane Pledge Energy Pathway is targeted at addressing methane leaks, venting, and flaring in the oil and gas sector.
  - **Objective:** The goal is to reduce methane emissions, a potent greenhouse gas, to mitigate climate change impacts.
  - **Strategy:** This initiative aims to implement measures and technologies to minimize methane emissions, promoting environmental sustainability in the energy sector.
- **Collective 2030 Zero-Emission Vehicle Goal and Green Shipping Challenge:**
  - **Aim:** The Collective 2030 Zero-Emission Vehicle Goal and Green Shipping Challenge target the transportation sector.

- **Objective:** The focus is on reducing emissions from vehicles and shipping activities, crucial contributors to greenhouse gas emissions.
- **Strategy:** The initiative aims to encourage the adoption of zero-emission vehicles and promote sustainable practices in the shipping industry, thereby contributing to the overall reduction of carbon emissions in transportation.

- **Clean Energy Technologies Demonstration Challenge:**
  - **Aim:** The Clean Energy Technologies Demonstration Challenge aims to decrease dependence on fossil fuels and promote the adoption of clean energy technologies.
  - **Objective:** The goal is to accelerate the development and deployment of innovative clean energy solutions.
  - **Strategy:** This initiative supports the demonstration of cutting-edge clean energy technologies, fostering a transition towards sustainable and renewable energy sources.
- **Efforts to Enhance Food Security:**
  - **Aim:** Efforts to Enhance Food Security focus on improving fertilizer efficiency in agriculture.
  - **Objective:** The initiative aims to enhance food production while minimizing the environmental impacts associated with excessive fertilizer use.
  - **Strategy:** By promoting efficient fertilizer practices, this initiative seeks to ensure food security, reduce greenhouse gas emissions from agriculture, and enhance sustainable agricultural practices.

INTERNATIONAL ORGANIZATIONS RELATED TO CLIMATE CHANGE

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is the leading international scientific body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988.

Objective

- To provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socioeconomic impacts.

Composition

The IPCC is divided into three Working Groups and a Task Force.

- Working Group I (WG I) deals with The Physical Science Basis of Climate Change,
- Working Group II (WG II) with Climate Change Impacts, Adaptation and Vulnerability and
- Working Group III (WG III) with Mitigation of Climate Change.
- Task Force on National Greenhouse Gas Inventories (TFI).

Features

- The IPCC is an organization of governments that are members of the United Nations or WMO. The IPCC currently has 195 members. IPCC continues to be the main body of the United Nations advising on climate change.
- It does not conduct its own research nor does it monitor climate related data or parameters. Thousands of people from all over the world contribute to the work of the IPCC.
- For the assessment reports, experts volunteer their time as IPCC authors to assess the thousands of scientific papers published each year to provide a comprehensive summary about Climate Change.
- The UN Climate change process receives the outputs of the IPCC and uses IPCC data and information as a baseline on the state of knowledge on climate change in making science-based decisions.
- IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC).

Reports generated by IPCC

Five Assessment Reports have been completed in 1990, 1995, 2001 and 2007, 2014.

The IPCC is now in its sixth assessment cycle, in which it is producing the Sixth Assessment Report (AR6) with contributions by its three Working Groups and a Synthesis Report, three Special Reports, and a refinement to its latest Methodology Report.

IPCC Assessment Reports

IPCC Assessment Reports cover the full scientific, technical and socio-economic assessment of climate Change. It is generally divided in parts which are as follows:

IPCC Assessment Report = {(WG I Report + WG II Report + WG III Report) + Three Special Reports Methodology Reports + Synthesis Report}

Special Reports

They are assessments of a specific issue. For AR 6, Three Special reports have been published including:

- **Special Report on Global Warming of 1.5ºC (2018):** With the adoption of the Paris Agreement, the UNFCCC requested that the IPCC produce a special report on "the impacts of global warming of 1.5°C above pre–industrial levels and related global greenhouse gas emissions pathways". The report, known as SR1.5, assesses what a 1.5°C warmer world would look like, and also the different pathways by which global temperature rise could be limited to 1.5°C
- **Special Report on Climate Change and Land (2019):** An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems". It shows that better land management can contribute to tackling climate change, but is not the only solution.
- **Special Report on the Ocean and Cryosphere in a Changing Climate (2019):** This IPCC Special Report was approved on 24 September 2019 by the 195 IPCC member governments. It provides new evidence for the benefits of limiting global warming to the lowest possible level – in line with the goal that governments set themselves in the 2015 Paris Agreement.

Methodology Reports

These reports provide practical guidelines for the preparation of greenhouse gas inventories under the UNFCCC.

The Synthesis Report

This report is the last of the AR6 publications to inform the 2023 Global Stocktake by the United Nations Framework Convention on Climate Change. The AR6 SYR is based on the content of the three Working Groups Assessment Reports.

- The purpose of this report is to provide policymakers with a summary of the previous reports in a way that is easy to understand, even for those without technical expertise.
- While it covers a broad range of policy-relevant scientific questions related to climate change, the report does not make any recommendations or impose any directives, in keeping with the tradition of IPCC reports.
- This report concludes the Sixth Assessment Report, which involved the collaborative effort of thousands of scientists over a span of eight years, beginning in February 2015.

IPCC published its **Synthesis Report** the 4th and final installment of the sixth assessment report (AR6). -

Key Findings Of This Report

The Earth's climate has undergone unprecedented changes in recent human history due to global warming induced by human activities, resulting in a temperature increase of 1.1 degrees Celsius.

While adaptation measures can increase resilience, the implementation of such solutions requires additional funding to achieve scalability.

Furthermore, there is a likelihood of more than 50% that global temperatures will surpass 1.5 degrees Celsius (2.7 degrees Fahrenheit) by the years between 2021 and 2040.

Recommendations In This Report

Deep systemic changes are needed across all economic sectors to reduce emissions. Some steps include:

- Widespread electrification
- Diversifying energy generation to include more wind, solar, and small-scale hydropower
- Conserving and restoring forests while also reducing tropical deforestation.

Accelerated financial support for developing countries from developed countries is a critical enabler, with a greater focus needed on public grant-based finance.

World Meteorological Organization (WMO)

WMO is the UN system's authoritative voice on the state and behavior of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources.

Background: It was established in 1950 and has its headquarters in Geneva, Switzerland. The WMO became the specialized agency of the United Nations in 1951 for meteorology (weather and climate), operational hydrology and related geophysical sciences.

Membership: The WMO Membership comprises 187 states and 6 territories.

- **World Meteorological Congress:** The WMO is governed by the World Meteorological Congress, which is composed of all WMO Members. The World Meteorological Congress meets every four years to review, and give policy guidance to, WMO Programmes.

Functions:

- WMO coordinates the activities of National Meteorological and Hydrological Services in 193 States and Territories so that basic weather, climate and water services
- WMO forecasts early warnings on flooding, drought, tropical cyclones, tornadoes and other extreme events.
- It also gives Predictions concerning locust swarms and the transport of pollutants (nuclear and toxic substances, volcanic ash).
- WMO issues Annual, Five-Year and Decadal Statements on the Status of the Global Climate.

Reports

- **State of Climate Services:** The report provides case studies, examples and explanations as to the role of climate information and services to support agriculture in the face of climate variability and change.
- **Greenhouse Gas Bulletin:** The annual bulletin is based on observations from the WMO Global Atmosphere Watch Programme. These observations help to track the changing levels of greenhouse gases and serve as an early warning system for changes in these key atmospheric drivers of climate change.

Global Climate Observing System

It was formed in 1992 as a result of the Second World Climate Conference. It aims to secure essential observations and information for addressing climate-related concerns, making them accessible to all potential users.

- The WMO released the **GCOS Implementation Plan 2022**, which identifies areas of improvement and gaps in earth observations. The plan assesses the status of global climate observations of the atmosphere, land, and ocean regularly and provides recommendations for improving them.
- The plan is co-sponsored by the World Meteorological Organization, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), and the United Nations Environment Programme (UNEP).

World Climate Research Programme (WCRP)

It is an international research program that was established in 1980 to improve understanding of the Earth's climate system and to provide scientific information for decision-making related to climate change. It aims promote collaboration and interdisciplinary research to address key questions related to climate change, such as how the Earth's climate system responds to natural and human-induced factors, and how it might evolve in the future.

CLIMATE FINANCE

Climate Finance refers to finance for activities aiming to mitigate or adapt to the impacts of climate change.

Difference between Adaptation Fund and Mitigation Fund

Adaptation Fund	Mitigation Fund
• Adaptation Fund concentrates on ways to change the way we live in order to be resilient to climate change. • This fund may cost more than climate mitigation. Adaptation calls for holistic and inclusive thinking.	• Mitigation Fund concentrates on reduction of emissions that cause climate change. • Currently, most funds are directed towards climate mitigation. For example, in 2018 approximately 93% of climate funds were geared to mitigation and just 5% for adaptation.

The Adaptation fund under the Kyoto Protocol

The Adaptation fund was established to finance adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol.

- In the first commitment period (2008-2012), the Fund was financed mainly with a share of proceeds from CDM project activities.
- In Doha, in 2012, it was decided that for the second commitment period (2013-2020), international emissions trading and joint implementation would also provide the Adaptation Fund with a 2 percent share of proceeds.

Global Environment Facility (GEF)

It is a unique partnership of 18 agencies — including United Nations agencies, multilateral development banks, national entities and international to address the world's most challenging environmental issues.

- **Background:** It was established in 1991 as a pilot program in the World Bank. In 1994, the GEF was restructured and moved out of the World Bank system to become a permanent, separate institution.
- **Governing Mechanism:** The GEF is governed by a council made up of representatives from the countries and organizations that contribute to its funding.
- **Focus Areas**: The GEF focuses on **six areas** of environmental concern: biodiversity, climate change, international waters, land degradation, persistent organic pollutants (POPs), and ozone depletion.
- **Financial Mechanism for five major international environmental conventions:**
  - the Minamata Convention on Mercury,
  - the Stockholm Convention on Persistent Organic Pollutants (POPs),
  - the United Nations Convention on Biological Diversity (UNCBD),
  - the United Nations Convention to Combat Desertification (UNCCD) and
  - the United Nations Framework Convention on Climate Change (UNFCCC).
- **GEF administered Funds:**
  - **GEF Trust Fund:**
    - The GEF Trust Fund was established in 1991
    - It supports projects in six focal areas: biodiversity, climate change, international waters, land degradation, chemicals and waste, and sustainable forest management.
  - **Special Climate Change Fund (SCCF):**
    - The SCCF was created in 2001
    - The GEF's new climate change adaptation strategy for the 2022-2026 period will focus SCCF support in the following two priority areas: 1) Supporting the adaptation needs of Small Island Developing States (SIDS) and 2) Strengthening technology transfer, innovation, and private sector engagement.
    - The SCCF supported the launch of the **Climate Resilience and Adaptation Technology Transfer Facility (CRAFT)**-the world's first private sector investment vehicle for climate resilience and adaptation.
  - **Least Developed Countries Fund (LDCF):**
    - It was created in 2001
    - LDCF support helps countries implement the National Adaptation Programme of Action (NAPAs) – country-driven strategies for addressing their most urgent adaptation needs.
    - It also supports the implementation of National Adaptation Plans (NAPs), and the Least Developed Countries work program under the UNFCCC.
    - The LDCF, along with the Special Climate Change Fund (SCCF), is mandated to serve the Paris Agreement.

Green Climate Fund (GCF)

It is a global fund established under the United Nations Framework Convention on Climate Change (UNFCCC) to support developing countries in their efforts to address climate change.

- The GCF was established in 2010 and is headquartered in Incheon, South Korea.
- The GCF is funded by contributions from developed countries, as well as from public and private sources.
- It allocates its resources to low-emission and climate-resilient projects and programmes in developing countries.

World Bank Administered Funds

- **Climate Investment Funds:**
  - It is a funding mechanism established by the World Bank in 2008.It is an enabler of pioneering climate-smart planning and climate action in low and middle-income economies.
  - Climate Investment Funds comprises two funds, 1) the Clean Technology Fund and 2) the Strategic Climate Fund.
- **Biocarbon Fund:**
  - It was set up as a public-private sector initiative managed by the World Bank
  - The fund comprises over 20 projects divided into two categories: 1) the UNFCCC Clean Development Mechanism projects and 2) the Verified Carbon Standard projects.

Global Energy Efficiency and Renewable Energy Fund (GEEREF)

GEEREF is a public-private partnership (PPP) designed to maximize the private finance leveraged through public funds funded by the European Commission and managed by the European Investment Bank (EIB).

Amazon Fund (Fundo Amazônia)

It is a financial mechanism established by the Brazilian government in 2008 to support the conservation and sustainable use of the Amazon rainforest.

Addis Ababa Action Agenda (AAAA) on Financing for Development

It is a global framework for financing sustainable development. It was adopted by the United Nations member states in July 2015 at the Third International Conference on Financing for Development in Addis Ababa, Ethiopia.

INDIAN INITIATIVES TO ADDRESS CLIMATE CHANGE

India's pledges under NDCs

- **Emission intensity:** India has pledged to reduce the emissions intensity (total amount of emissions emitted for every unit of GDP) of the GDP by **45% by 2030**, compared to the **2005 level**. The goal to reduce **emissions intensity** and improve **energy efficiency** is not **sector specific**.
- **Share of non-fossil-based energy:** India has planned to achieve about 50% of cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.
    - India plans to use low-cost international finance, including the **Green Climate Fund (GCF)**, to achieve this objective.
- **Sustainable living:** India will promote sustainable living based on traditions, conservation, and moderation to combat climate change.
- **Other pledges:**
    - Adopting a cleaner path for economic development
    - Creating additional carbon sinks of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover.
    - Adapting to climate change by improving investments in development programmes in vulnerable sectors
    - Mobilizing funds from developed countries for implementing better mitigation and adaptation actions
    - Building architectural framework for quick solution and better research and development for climate technologies.

National climate vulnerability assessment report

- It is released by The Department of Science and Technology (DST).
- It identifies the most vulnerable states and districts in India with respect to current climate risk and key drivers of vulnerability.
- In 2022, this report identified Jharkhand, Mizoram, Orissa, Chhattisgarh, Assam, Bihar, Arunachal Pradesh, and West Bengal as states highly vulnerable to climate change. These states, mostly in the eastern part of the country, require prioritization of adaptation interventions, the report pointed out.

The National Action Plan on Climate Change (NAPCC)

The National Action Plan on Climate Change (NAPCC) was released on 30th June 2008 by the Prime Minister's Council on Climate Change. It outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path. As part of the Climate Change Action program. The scheme has been extended up to 2025-26.

There are eight ―National Missions‖ which form the core of the National Action Plan. They focus on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

1. **National Solar Mission (NSM) (Ministry of New and Renewable Energy)**

NSM was launched in 2010 with the aim of establishing India as a global leader in solar energy. The ambitious goal is to achieve 280 GW of installed solar capacity by 2030. The Mission also targets installing 100 GW grid-connected solar power plants by the year 2022.

Some of key initiatives, institutions and programmes under NSM:

- International Solar Alliance (ISA).
- One Sun, One World & One Grid (OSOWOG)
- Green Energy Corridors
- The PM-KUSUM
- National Smart Grid Mission
- Smart Meter National Programme

2. **National Mission for Enhanced Energy Efficiency (NMEEE) (Ministry of Power)**

NMEEE consists of four initiatives to enhance energy efficiency in energy intensive industries:

- **Perform, Achieve and Trade (PAT):** It sets energy efficiency targets for energy-intensive industries and allows them to trade excess energy savings as tradable instruments (Energy Saving Certificates (ESCerts).
- **Market Transformation for Energy Efficiency (MTEE):** Accelerating the shift to energy efficient appliances in specific applications through innovative measures.
- **Energy Efficiency Financing Platform (EEFP):** Facilitating Financial Institutions to invest in Energy Efficiency Projects and Programmes. The platform includes a range of financial instruments such as loans, guarantees, and equity financing.
- **Framework for Energy Efficient Economic Development (FEEED):** Developing fiscal instruments to leverage financing for Energy Efficiency through risk mitigation.

Some of key initiatives, institutions and programmes under eight NMEEE:

- Standards and Labeling programme.
- Energy Conservation Building Code (ECBC)
- Energy Conservation Act, 2001
- Electricity Act, 2003
- National Renewable Energy Act 2015
- Zero Defect, Zero Effect policy
- India Cooling Action Plan (ICAP)
- National Hydrogen Energy Mission (NHM)
- Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)
- Akshay Urja Portal
- The India Renewable Idea Exchange (IRIX) Portal
- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)

Tradable Certificates Issued in India:

Renewable Energy Certificate (REC): It is a market-based instrument to promote renewable energy and facilitate compliance of renewable purchase obligations (RPO). It is aimed at addressing the mismatch between availability of renewable energy resources in state and the requirement of the obligated entities to meet the renewable purchase obligation (RPO). One Renewable Energy Certificate (REC) is treated as **equivalent to 1 MWh**.

Energy Saving Certificates (ESCerts): It is issued under Perform, Achieve and Trade (PAT) scheme. They are issued to those plants that have achieved excess energy savings over their targets. Units that are unable to meet the targets either through their own actions or through purchase of ESCerts are liable to financial penalty under the Energy Conservation Act.

3. National Mission on Sustainable Habitat (NMSH) (Ministry of Housing & Urban Development)

NMSH aims at Promoting low-carbon urban growth towards reducing GHG emissions intensity for achieving India's INDC. The revised NMSH (from 2020-2030.) has identified five thematic areas, namely:

Energy and Green Building

- **Objective:** To focus on reducing the energy consumption for lighting, heating, and cooling.
- **Key mitigation and adaptation strategy:** Undertake energy audits of all municipal services, including water supply, sewage etc.
- **Linkages with SDGs:**

SDG 7: Affordable and Clean Energy

SDG 11: Sustainable Cities and Communities

Urban Planning, Green Cover and Biodiversity

- **Objective:** To have integrated urban and regional planning approaches to eco-sensitive areas of water bodies.
- **Key mitigation and adaptation strategy:** Mapping of all eco-sensitive zones, biodiversity rich areas, and natural assets in the city.
- **Linkages with SDGs:**

SDG 13: Climate Actions

SDG 15: Life on Land

Mobility and Air Quality

- **Objective:** To implement strategies focusing on multi-modal mobility options to arrest the rapid growth of private motor vehicles.
- **Key mitigation and adaptation strategy:** Adopting cleaner and environment-friendly technologies, such as Electric Vehicles (EVs), Compressed Natural Gas (CNG), biofuels, etc.
- **Linkages with SDGs:**

SDG 7: Affordable and Clean Energy

SDG 11: Sustainable Cities and Communities

Water Management

- **Objective:** To augment existing water resources by adopting rain-water harvesting (RWH), recycling/reuse of treated sewage, and promoting circular economy of water through development of City Water Balance Plan (CWBP).
- **Key mitigation and adaptation strategy:** Publishing Rapid Flood Risk Assessment Report to understand the reasons for flooding/water stagnation in the city.

- **Linkages with SDGs:**

  SDG 6: Clean Water and Sanitation

Waste Management

- **Objective:** To focus on the need for cities to prioritise actions for waste reduction and waste management, and promote waste to-energy plants.
- **Key mitigation and adaptation strategy:** Segregating waste and 3R (Reduce, Reuse, and Recycle) principles for better waste management.
- **Linkages with SDGs:**

  SDG 12: Responsible Consumption and Production

Some of key initiatives, institutions and programmes under NMSH:

- Atal Mission on Rejuvenation and Urban Transformation (AMRUT)
- Smart Cities Mission,
- ClimateSmart Cities Assessment Framework (CSCAF)
- Swachh Bharat Mission
- 4R Approach (Reduce, Reuse, Recycle, and Recovery)
- Urban Development Plan Formulation and Implementation (UDPFI) guidelines
- Atal Jyoti Yojana
- JJM-U: Jal Jeevan Mission - Urban
- City Climate Action Plan (CCAP)
- Climate Centre for Cities (C-Cube)
- FAME (Faster Adoption and Manufacturing of Electric/Hybrid)
- GHTC - India: Global Housing Technology Challenge - India
- LEED: Leadership in Energy and Environmental Design
- LHP: Light House Project
- PMAY-U Pradhan Mantri Awas Yojana - Urban
- NCMC: National Common Mobility Card
- NUTP: National Urban Transport Policy
- NIUA: National Institute of Urban Affairs

4. National Water Mission (NWM) (Ministry of Jal Shakti)

The National Water Mission has set five goals to achieve effective management of water resources in India. These goals include:

- Creating a comprehensive water database and assessing the impact of climate change.
- Promoting water conservation and preservation through citizen and state actions.
- Giving focused attention to vulnerable areas.
- Increasing water use efficiency by 20%.
- Promoting basin-level integrated water resources management.

The 1st All India Annual States' Ministers Conference on "Water Vision@2047" was held (January 2023) in Bhopal, Madhya Pradesh.

"Water Vision @ 2047 is an important dimension of the journey of Amrit Kaal for the next 25 years".

Some of key initiatives, institutions and programmes under NWM:

- 'Catch the Rain' Awareness Generation Campaign.
- National Aquifer Mapping and Management Program.
- National Water Policy 2012
- National Water Awards
- GroundWater Resources Assessment
- Jal Shakti Abhiyan (JSA)
- Atal Bhujal Yojana
- Namami Gange Mission
- NITI Aayog's Composite Water Management Index
- National Water Informatics Centre

5. National Mission for Sustaining the Himalayan Ecosystem (Department of Science and Technology)

The Central Government launched NMSHE in 2010 but was formally approved by the government in 2014.

Objective:

- To prevent melting of the Himalayan glaciers.
- To protect biodiversity in the Himalayan region.
- To conserve Traditional knowledge societies and their livelihood.

Coverage:

The Mission covers all 12 Himalayan States of India in the Indian Himalayan region (IHR). These include:

- 10 hill States that is Jammu & Kashmir (Now UT of J&K and Ladakh), Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya.
- Two partial hill States namely, Assam and West Bengal.

Some of key initiatives, institutions and programmes under eight NMSHE:

- The National Center for Himalayan Glaciology
- Himalayas Climate Change Portal
- Himalayan Sustainable Development Forum (HSDF)
- Inter-University Consortium on Cryosphere and Climate Change

6. National Mission for a Green India (GIM) (Ministry of Environment, Forest and Climate Change)

The GIM has identified the following key objectives to achieve its mission:

- to increase the country's forest cover from the current level of around 23% to 33% of its total geographic area.
- to improve the ecosystem services provided by forests, including soil and water conservation, biodiversity conservation.
- to create sustainable livelihood opportunities for local communities by promoting agroforestry, non-timber forest produce, and eco-tourism

National Initiative on Sea buckthorn under the Green India Mission:

It seeks to promote sea buckthorn as a priority species for afforestation of degraded lands as well as ensuring good health and poverty alleviation in the Indian Himalayan region It focuses on Leh and Kargil areas of Ladakh; Lahaul-Spiti and Kinnaur areas of Himachal Pradesh and Chamoli areas of Uttarakhand.

About Sea buckthorn

- Sea buckthorn is a shrub which produces an orange-yellow colored edible berry.
- Sea buckthorn plays a vital role in combating global warming, environmental conservation of high-altitude areas of the Indian Himalayan region for health care and poverty alleviation.

Some of key initiatives, institutions and programmes under GIM:

- National Agroforestry Policy
- Joint Forest Management Program
- National Afforestation Program
- Green Skill Development Program

7. National Mission for Sustainable Agriculture (NMSA) (Ministry of Agriculture)

- NMSA has been made operational from the year 2014-15.
- It has been formulated for enhancing agricultural productivity especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation.
- NMSA has following four (4) major programme components or activities:
- **Rainfed Area Development (RAD):** RAD adopts an area-based approach for development and conservation of natural resources along with farming systems.
- **On Farm Water Management (OFWM):** The program emphasizes the effective harvesting and management of rainwater in conjunction with the RAD component. The program encourages the digging of farm ponds using MGNREGA funds and earth moving machinery to conserve water on farms.
- **Soil Health Management (SHM):** The program links soil fertility maps with macro-micro nutrient management, appropriate land use based on land capability, judicious application of fertilizers, and minimizing soil erosion/degradation.
- **Climate Change and Sustainable Agriculture: Monitoring, Modeling and Networking (CCSAMMN):** CCSAMMN provides creation and bidirectional (land/farmers to research/scientific establishments and vice versa) dissemination of climate change related information and knowledge.

Some of key initiatives, institutions and programmes under NMSA:

- Zero-Budget Natural Farming (ZBNF)
- Paramparagat Krishi Vikas Yojana (PKVY)
- Rashtriya Krishi Vikas Yojana
- National Project on Organic Farming
- National Mission on Agriculture Extension & Technology
- National Initiative for Climate Resilient Agriculture (NICRA)
- Integrated Watershed Management Programme (IWMP)
- Mission for Integrated Development of Horticulture (MIDH)

8. National Mission on Strategic Knowledge for Climate Change (Department of Science and Technology)

It seeks to build a vibrant and dynamic knowledge system that would inform and support national action for responding effectively to the objective of ecologically sustainable development.

National Adaptation Fund for Climate Change (NAFCC)

It is a Central Sector Scheme which was set up in the year 2015-16.

Aim: To fund concrete adaptation projects/programmes aligned with the relevant Missions under National Action Plan on Climate Change (NAPCC) and the State Action on Climate Change (SAPCCs).

- The activities under this scheme are implemented in a project mode. The projects related to adaptation in sectors such as agriculture, animal husbandry, water, forestry, tourism etc. are eligible for funding under NAFCC.
- **National Implementing Entity (NIE):** National Bank for Agriculture and Rural Development (NABARD)

Long Term Low Emission Development Strategy (LT-LEDS)

India unveiled its long-term strategy of achieving net-zero emissions by 2070 at UNFCCC's COP27 in Egypt's Sharm el-Sheikh.

- **Approach:** It is based on the following four key considerations that underpin its long-term low-carbon development strategy:
  - India has contributed little to global warming
  - India has significant energy needs for development.
  - India is committed to pursuing low-carbon strategies for development and is actively pursuing them
  - India needs to build climate resilience.
- **Focus Areas:** India's LT-LEDS rests on **seven** key transitions to low-carbon development pathways.

Focus Area	
Energy Sector	**Low-carbon development pathways for the energy sector:** • Expanding **renewables** and **strengthening the grid** • Exploring and/or supporting other **low carbon technologies** • Focusing on **demand-side** management • **Rational utilization of fossil fuel** resources, with due regard to energy security • Determining **green taxonomy** and **optimum energy mix**
Transportation Sector	**Low-carbon options for the transportation sector:** • Encouraging improved fuel **efficiency** • Phased transition to **cleaner fuels** • Modal shift towards **public** and **less polluting modes of transport** • **Electrification** across multiple transport modes • **Demand side** management • Traffic management and **intelligent transport systems**
Urban Design	**Pathways for sustainable urbanization:** • Mainstreaming **adaptation measures** in the built environment and urban systems • Promote **resource efficiency** within **urban planning guidelines,** policies, and bylaws • Promote **climate responsive and resilient building design,** construction, and operation in existing and future buildings and in urban systems • Promote **low-carbon municipal service delivery** through resource efficiency, management of water, solid, and liquid waste
Industrial Sector	**Decoupling of industrial growth from carbon emissions:** • Improve energy and resource efficiency, with efforts to increase the use of **natural and bio-based materials** • Process and fuel **switching and electrification in manufacturing,** as feasible and viable • Enhance material efficiency and recycling, strengthening the **circular economy** • Promote **green hydrogen technology** and infrastructure • Explore options for sustainable **growth of hard-to-abate sectors** • Low carbon and sustainable growth of **MSMEs**

Focus Area	
Carbon Capture Utilization and Storage (CCUS) Technologies	• This is a new **sector being explored** world over and may also be explored in the Indian context. • This shall require substantial international support through **innovation, technology transfer, climate-specific finance and capacity building.**
Enhancing Forest and vegetation cover	**Elements of long-term low emission development includes:** • Restoration, conservation, and management of **forests and their plant, animal and microbial genetic resources** • Restoration, conservation, and management of **trees outside forests** • **Strengthening infrastructure** of State Forest departments, including upgradation of nurseries
Economic and financial aspects of low-carbon development	**The focus areas include:** • Mainstreaming of **climate-specific finance**, especially **multilateral climate finance** • **Technology** transfer, **capacity** building and linkages to **international trade** • **New multilateral mechanisms** for supporting innovation, and technology development

Mission LiFE ('Lifestyle for Environment')

LiFE is an India-led global mass movement to nudge individual and community action to preserve the environment.

- It was introduced by India at COP26 at Glasgow in 2021. Further, in August 2022, India included LiFE in its updated Nationally Determined Contributions (NDCs) submitted to UNFCCC.
- LiFE puts individual and collective duty on everyone to live a life that is in tune with Earth and does not harm it. Those who practice such a lifestyle are recognised as Pro Planet People, under Mission LiFE.
- It is the mantra to reverse historical and cultural wrongs wreaked upon the environment.

Objectives:

- To mobilize at least one billion Indians and other global citizens to take individual and collective action for protecting and preserving the environment in the period 2022 to 2027.
- Within India, at least 80% of all villages and urban local bodies are aimed to become environment-friendly by 2028.

Approaches of Mission LiFE:

Focus on Individual Behaviors

- Making LiFE a mass movement (Jan Andolan)
- Focus on behaviors and attitudes of individuals and communities.

Co-create Globally

- Crowdsource the best ideas from think tanks, universities and international organizations.

Leverage local cultures

- Leverage on climate-friendly norms, beliefs and household practices of different cultures in the world to drive the campaign.

Three-pronged strategy of Mission LiFE:

As a global programme, Mission LiFE envisions three core shifts in our collective approach towards sustainability, achieved in a phased manner:

Change in Demand (Phase I): Nudging individuals across the world to practice simple yet effective environment-friendly actions in their daily lives.

Example:

- Switching off vehicle engines at traffic lights.
- Turning off taps when not in use
- Switching to alternatives to single-use plastic bags.

Change in Supply (Phase II): Changes in large scale individual-demand is expected to gradually nudge industries and markets to respond and tailor supply & procurement as per the revised market demands.

Example: Alternatives to single use plastics

Change in Policy (Phase III): By influencing the demand and supply dynamics of India and the world, the long-term vision of Mission LiFE is to trigger shifts in large scale industrial policy and government policy that can support both sustainable consumption and production.

Example: Electric Mobility

Panchamrit

India presented the following five nectar elements (Panchamrit) of India's climate action at COP 26. The elements include:

- Reach 500GWNon-fossil energy capacity by 2030.
- 50 per cent of its energy requirements from renewable energy by 2030.
- Reduction of total projected carbon emissions by one billion tonnes from now to 2030.
- Reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels.
- Achieving the target of net zero emissions by 2070.

Leaders in Climate Change Management Program (LCCM)

The program is a collaboration between NIUA, WRI India, the United Nations Environment Programme (UNEP), and the Indian School of Business (ISB). The program aims to train urban professionals to lead climate action in India's various sectors and locations. To facilitate the program, the Administrative Training Institute (ATI) in Mysuru has partnered with NIUA and WRI India, becoming its first delivery partner.

Energy Conservation (Amendment) Act, 2022

Energy Conservation (Amendment) Act, 2022 came into force in December 2022. It amends the Energy Conservation Act, 2001. It is aimed at enabling India achieve "Panchamrit", promote renewable energy and develop the domestic carbon market to combat climate change.

Key Features:

- **Carbon credit trading:**
  - The Amendment Act empowers the Central Government to specify a carbon credit trading scheme aimed at reducing greenhouse gas emissions, and hence, addressing climate change.
  - The Act empowers any other person, other than the designated consumer, to purchase a carbon credit certificate on a voluntary basis.
- **Obligation to use non-fossil sources of energy:** The Act empowers the Central Government to specify minimum share of consumption of non-fossil sources by designated consumers as energy or feedstock.
- **Energy conservation code for buildings:** It substitutes the definition of 'energy conservation building codes' with 'energy conservation and sustainable building code'.
- **Standards for vehicles and vessels:** Energy consumption standards will apply also vehicles and vessels. Previously, the energy consumption standards could be specified for equipment and appliances, which consumed, generated, transmitted, or supplied energy.
- **Penalty:** It brings in new penalties and aggravates existing penalties for violations of certain provisions of the Act.
- **Governing Council of Bureau of Energy Efficiency (BEE):** The Amendment Act Increases and diversifies number of members and secretaries in governing council of BEE.

The Skill Council for Green Jobs

Green Jobs are environmentally beneficial jobs that directly contribute to the planet's well-being. They include roles related to renewable energy, resource conservation, and energy efficiency.

In October 2015, the Union Government launched the Skill Council for Green Jobs, an independent and industry-led initiative supported by the Ministry of New and Renewable Energy (MNRE) and the Confederation of Indian Industry (CII). The council's primary goal is to assist manufacturers and service providers in India's "green business" sector such as renewable energy, waste management, green transport, and urban farming.

The India Greenhouse Gas Program

The program was established in 2012 as a collaborative effort led by World Resource Institute (WRI) India, Confederation of India Industry (CII), and The Energy and Resource Institute (TERI). It is a voluntary framework for industries to measure and manage their greenhouse gas emissions.

The Climate Smart Cities Assessment Framework

Launched in 2019 by MoHUA under Smart Cities Mission, it is a first-of-its-kind assessment framework on climate relevant parameters. It seeks to provide a clear roadmap for Indian cities towards combating climate change while planning their actions within the city including investments.

- The Climate Smart Cities Assessment Framework 2.0 has 28 indicators across five categories namely; (i) Energy and Green Buildings, (ii) Urban Planning, Green Cover & Biodiversity, (iii) Mobility and Air Quality, (iv) Water Management and (v) Waste Management.

Initiatives to tackle methane emissions in India

Seaweed-based Animal Feed:

- **Led by:** Central Salt & Marine Chemical Research Institute (CSMCRI)
- **About:** The CSMCRI has developed a seaweed-based animal feed additive formulation to reduce methane emissions from cattle.

Anti-methanogenic feed supplement "Harit Dhara"

- **Launched:** 2021
- **Led by:** Indian Council of Agricultural Research (ICAR)
- **About:** The anti-methanogenic feed supplement has a potential to reduce cattle methane emissions by 17-20%.

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CLEAN ENERGY

Clean energy refers to renewable energy sources that have minimal environmental impact and play a vital role in reducing greenhouse gas emissions and combating climate change. According to the UN, "Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed". Examples include solar energy, wind energy, geothermal energy etc.

Important Organizations

- **International Energy Agency:** It is a Paris-based autonomous intergovernmental organization, established in 1974. It provides policy recommendations, analysis and data on the entire global energy sector. There are 31 member countries and 11 association countries of the IEA which represent 75% of global energy demand. India is not its founding member, but became an associate member of it in March 2017.
- **Clean Energy Ministerial (CEM):** It is a high-level global forum to promote policies and programs that advance clean energy technology, to share lessons learned and best practices. It aims to encourage the transition to a global clean energy economy. The CEM Secretariat is hosted by the IEA since 2018.
- **International Renewable Energy Agency:** Founded in 2009, it is an intergovernmental organization. It aims to facilitate cooperation, advance knowledge, and promote the adoption and sustainable use of renewable energy. There are 167 member countries along with the EU.

Current Status of Renewable Energy in India

According to the Ministry of Renewable Energy,

- India currently has total renewable energy installed capacity of 168.96 GW.
- A total of 3,16,754.86 MU of electricity has been generated from renewable energy sources in the current year (2022-23)
- Renewable Energy installed capacity has increased by 286% in the last 7.5 years.
- India stands at 4th Global Position for overall installed renewable energy capacity (As per REN21Renewables 2022 Global Status Report)

Source	Installed Capacity
Wind Power	42.02 GW
Solar Power	64.38 GW
Biomass	10.77 GW
Small Hydro Power	4.93 GW
Waste to Energy	0.52 GW

Targets:

To meet the energy needs of people, to preserve the fragile environment, and to transition the Indian economy towards the green path, India has the following targets:

- India will reach its **non-fossil energy capacity** to **500 GW** by 2030.
- India will meet **50%** of its **energy requirements from renewable energy** by 2030.
- India will reduce the **total projected carbon emissions** by **one billion tonnes** from now onwards till 2030.
- India will reduce the **carbon intensity** of its economy by less than **45%** by 2030.
- India will achieve the target of **Net Zero** by **2070**.
- India has set a target to produce **five million tons** of **green hydrogen** by 2030.

SOLAR ENERGY

Solar Power is generated by converting energy from Sun into thermal or electrical energy. The conversion of sunlight into electrical energy happens either through Photovoltaic Panels or through mirrors that concentrate solar radiation. It is the cleanest and most abundant renewable energy source available.

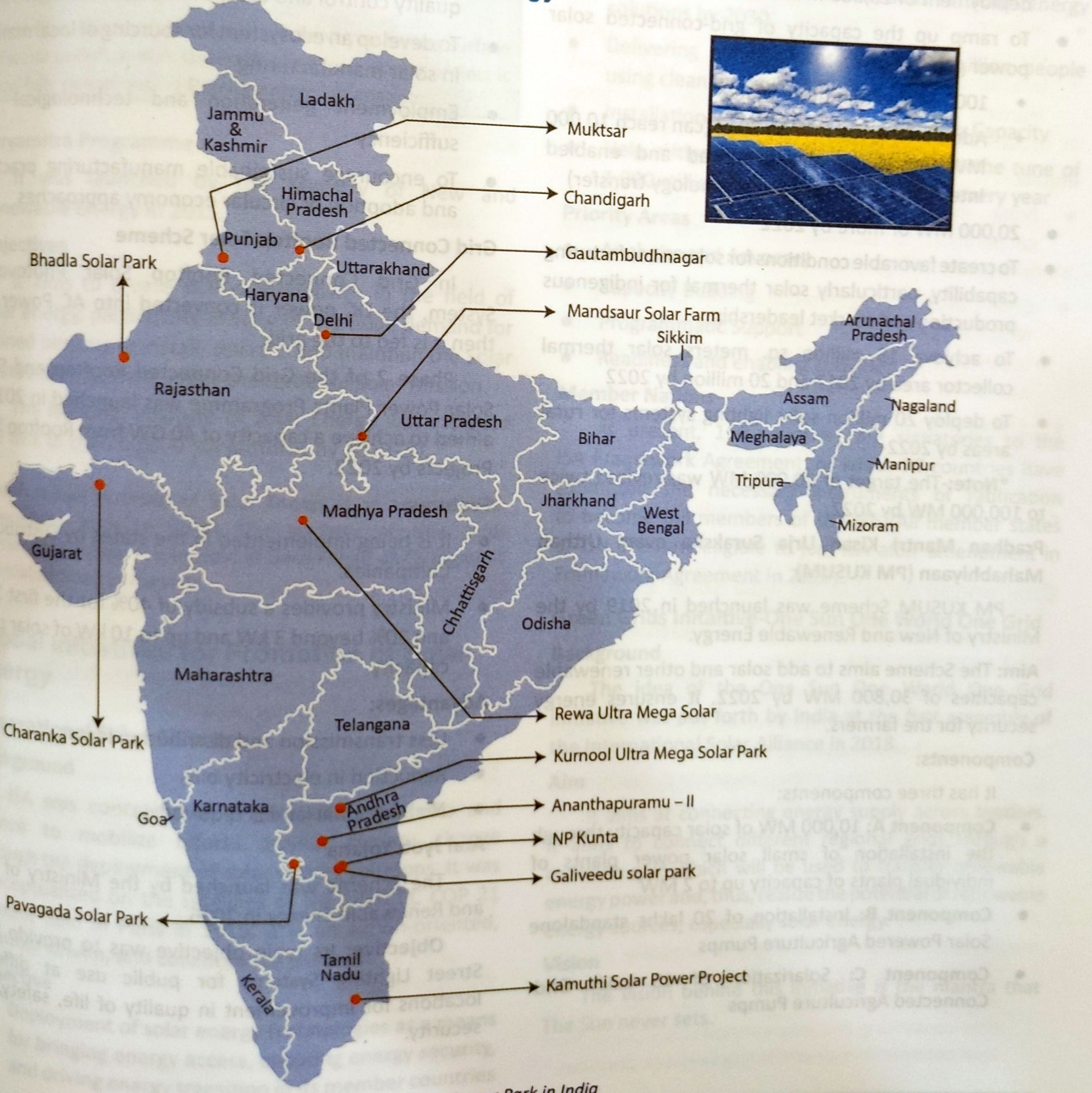
Present Status in India

Solar Energy has one of the highest potentials in India. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The energy potential is about 6,000 million GWh of energy per year. The installed capacity of Solar Energy in India is 64.38 GW.

Advantages and Disadvantages Associated of Solar Energy

Advantages	Disadvantages
It is a Renewable source of energy and reduces carbon emissions	It is dependent on the weather
It can reduce transmission and distribution losses	Most of the parts are imported so the initial cost is high
It has low maintenance cost	Domestic manufacturing infrastructure is not strong to compete with China
It will help to meet the increasing demand of electricity	High population density also causes the problem of land availability
It is abundant and can be generated in almost all parts of the country	Solar waste is also a major issue which needs to be tackled
It can supplement the income of farmers as land can also be utilized for solar power generation	

Indian Initiatives for Promotion of Solar Energy



Solar Power Park in India

National Solar Mission

Jawaharlal Nehru National Solar Mission is one of the National Missions of India's National Action Plan on Climate Change. It was inaugurated by the government in 2010.

Objective:

To establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.

Target:

- To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022
- To ramp up the capacity of grid-connected solar power generation to-
  - 1000 MW within three years
  - Additional 3,000 MW by 2017 (can reach 10,000 MW based on the enhanced and enabled international finance and technology transfer)
- 20,000 MW or more by 2022
- To create favorable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership
- To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022
- To deploy 20 million solar lighting systems for rural areas by 2022

***Note:**-The target of 20,000 MW was revised twice to 100,000 MW by 2022.

Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM KUSUM)

PM KUSUM Scheme was launched in 2019 by the Ministry of New and Renewable Energy.

Aim: The Scheme aims to add solar and other renewable capacities of 30,800 MW by 2022. It ensures energy security for the farmers.

Components:

It has three components:

- **Component A:** 10,000 MW of solar capacity through the installation of small solar power plants of individual plants of capacity up to 2 MW
- **Component B:** Installation of 20 lakhs standalone Solar Powered Agriculture Pumps
- **Component C:** Solarization of 15 Lakh Grid-Connected Agriculture Pumps

Production Linked Incentive Scheme under National Programme on High-Efficiency Solar PV Modules

It aims to promote the manufacturing of high-efficiency solar PV modules in India and thus reduce import dependence in the area of Renewable Energy.

Objectives

- It is designed to achieve the following objectives:
- To build up solar PV manufacturing capacity of high-efficiency modules
- To bring cutting edge technology to India for manufacturing high-efficiency modules
- To promote setting up of integrated plants for better quality control and competitiveness
- To develop an ecosystem for sourcing of local material in solar manufacturing
- Employment generation and technological self-sufficiency
- To encourage sustainable manufacturing practices and adoption of circular economy approaches

Grid Connected Rooftop Solar Scheme

In Grid Connected Rooftop Solar Photovoltaic System, the DC power is converted into AC Power and then it is fed to the grid.

Phase 2 of the Grid Connected Rooftop and Small Solar Power Plants Programme was launched in 2019. It aimed to achieve a capacity of 40 GW from Rooftop Solar Projects by 2022.

Features:

- It is being implemented in the states by Distribution Companies.
- Ministry provides a subsidy of 40% for the first 3 kW and 20% beyond 3 kW and up to 10 kW of solar panel capacity.

Advantages:

- Less transmission and distribution losses
- Reduction in electricity bills
- No additional land is required

Atal Jyoti Yojana

The Scheme was launched by the Ministry of New and Renewable Energy in 2016.

Objective: Its main objective was to provide Solar Street Lighting Systems for public use at different locations for improvement in quality of life, safety, and security.

Launch Phases:

- Phase 1- Parliamentary constituencies of the states of Assam, Bihar, Jharkhand, Odisha, and Uttar Pradesh
- Phase 2- Parliamentary constituencies of Phase 1, Hill States/UTs, North-Eastern States, Island UTs and aspirational districts not covered in above mentioned states.

Achievements:

- 1.35 lakh solar street lights were installed
- 1.37 lakh solar street lights were installed

DO YOU KNOW?

Floating Solar Plants:

Under this, Photovoltaic panels are deployed on the surface of water bodies. India's largest floating solar power project is now fully operational at **Ramagundam, Telangana.**

Suryamitra Programme

It was launched by the Ministry of New and Renewable Energy in 2015.

Objectives

It aims to create skilled manpower in the field of solar energy, particularly in view of the huge demand for trained persons to install, operate and maintain the Solar Photovoltaic System under the National Solar Mission.

The National Institute of Solar Energy was assigned the task to train 50,000 Suryamitras by 2019-20.

The National Institute of Solar Energy is an autonomous specialized institute under the Ministry of New and Renewable Energy. It is located at Gwal Pahari on Gurugram-Faridabad Road in Haryana.

Global Initiatives for Promotion of Solar Energy

International Solar Alliance

Background

ISA was conceived as a joint effort by India and France to mobilize efforts against climate change through the deployment of solar energy solutions. It was conceptualized on the sidelines of the UNFCCC COP 21 Summit held in Paris in 2015. It is an action-oriented, member-driven, and collaborative platform.

Objective

- Deployment of solar energy technologies as a means for bringing energy access, ensuring energy security, and driving energy transition in its member countries
- Strives to develop and deploy cost-effective and transformational energy solutions powered by the sun to help member countries develop low-carbon growth trajectories, with particular focus on delivering impact in countries categorized as LDCs and Small Island Developing States.

Headquarters

Its Headquarters are in India (Interim Secretariat in Gurugram, Haryana).

Targets

- It is guided by its 'Toward 1000' Strategy which aims:
- USD 1,000 billion of investment in solar energy solutions by 2030
- Delivering energy access to 1,000 million people using clean energy solutions
- Installation of 1,000 GW of Solar Energy Capacity
- Help mitigate global solar emissions to the tune of 1,000 million tonnes of carbon dioxide every year

Priority Areas

- Analytics and Advocacy
- Capacity Building
- Programmatic Support
- Readiness and enabling activities

Member Nations

At present, 110 countries are signatories to the ISA Framework Agreement, of which 90 countries have submitted the necessary instruments of ratification to become full members of the ISA (All member states of UN are now eligible to join ISA after amendment in Framework Agreement in 2020).

Green Grids Initaitive-One Sun One World One Grid

Background

The idea of the One Sun One World One Grid Initiative was put forth by India at the first assembly of the International Solar Alliance in 2018.

Aim

It aims at connecting energy supply across borders. It aims to connect different regional grids through a common grid which will be used to transfer renewable energy power and, thus, realize the potential of renewable energy sources, especially solar energy.

Vision

The vision behind this initiative is the mantra that The Sun never sets.

Objectives

Achieving global connectivity through 3 key pillars of engagement:

- Political engagement and trust building between countries likely spearheaded by an intergovernmental steering group including representatives from each region
- Institutional engagement among international financial and technical institutions is likely spearheaded by a joint coordination committee that includes the ISA and other partners such as World Bank
- Research and Knowledge Sharing through the Green Powered Future Mission- a newly launched international innovation program with peer-to-peer learning networks of regulators and grid operators potentially being launched at a future stage

Impact

- Bring more technical, financial, and research cooperation to facilitate cross-border renewable energy transfer projects
- Create depth of organizational scale comprising of national governments, international financial and technical organizations, legislators, power system operators, and knowledge leaders
- Enable a faster leap towards a global ecosystem of interconnected renewables that are share for mutual benefit and global sustainability
- Provide momentum and a pool of investment towards low-carbon, innovative solar projects.

Challenges associated with Solar Energy

Solar Energy is faced with several issues that obstruct its full potential in India, such as:

- **High Initial Costs:** The upfront capital costs of installing solar power systems can be relatively high, including the cost of solar panels, inverters, batteries (if applicable), and other associated equipment. This initial investment can pose a financial barrier, especially for individuals or small businesses with limited financial resources.
- **Land Acquisition and Space Constraints:** India's high population density and competing land-use demands can pose challenges in acquiring suitable land for large-scale solar installations. Identifying suitable land areas and securing land rights can be time-consuming and may encounter resistance from local communities or conflicting land-use priorities.
- **Grid Integration and Infrastructure Challenges:** Integrating solar power into the existing electricity grid infrastructure is a critical challenge. Issues such as grid stability, variability of solar generation, and lack of adequate transmission and distribution infrastructure can impact the efficient integration and distribution of solar power.
- **Dependence on Imports:** India heavily relies on imported solar panels and other equipment, mainly from China, for its solar energy projects. This dependence on imports raises concerns about the availability, quality, and pricing of solar components, as well as the vulnerability to global market fluctuations and supply chain disruptions.
- **Technological Advancements and Skill Development:** Continuous technological advancements and innovation in solar energy are necessary to improve efficiency, reduce costs, and enhance the performance and durability of solar power systems. There is also a need for skilled manpower to design, install, operate, and maintain solar energy projects effectively.
- **Grid Parity and Tariff Structures:** Achieving grid parity, where the cost of solar power generation is competitive with conventional sources, is crucial for the long-term sustainability and scalability of solar energy. Ensuring appropriate tariff structures and mechanisms that incentivize solar power while balancing the interests of consumers and utilities is a challenge.
- **Limited Storage Infrastructure:** Energy storage technologies, such as batteries, are essential for ensuring an uninterrupted power supply and balancing the intermittent nature of solar energy. However, the deployment of energy storage infrastructure is still relatively limited in India, posing a challenge to maximizing the benefits of solar power.

WIND ENERGY

Wind energy harnesses the kinetic energy of the moving air with the help of large wind turbines located on land (Onshore) or in Sea or Freshwater (Offshore).

Advantages of Wind Energy

Wind energy has the following advantages that make it a good source of energy:

- It is environment-friendly
- India has good potential to harness wind energy

- It is a project with the fastest payback period
- Operation and maintenance costs are low
- It is a project with no investment in manpower

Status of Wind Energy in India

India has the fourth highest wind installed capacity in the world with a total installed capacity of 42.02 GW as per REN21 Renewables 2022 Global Status Report

Potential of Wind Energy in India

The Government has installed over 800 wind-monitoring stations all over the country through the National Institute of Wind Energy and has issued wind potential maps at 50m, 80m, and 100m above ground level.

Wind Power Potential in India at 100 meters above ground level (as per Ministry of New and Renewable Energy)

State/UT	Wind Potential (MW)
Gujarat	84431.33
Karnataka	55857.36
Maharashtra	45394.34
Andhra Pradesh	44228.60
Tamil Nadu	33799.65
Rajasthan	18770.49
Madhya Pradesh	10483.88
Telangana	4244.29
Odisha	3093.47
Kerala	1699.56
Puducherry	152.83
Chhattisgarh	76.59
Andaman & Nicobar	8.43
Lakshadweep	7.67
West Bengal	2.08
Goa	0.84
Total	302251.49

Initiatives for Promotion of Wind Energy

National Offshore Wind Energy Policy

Offshore Wind Energy is produced through the deployment of wind farms inside the water bodies.

India's first National Offshore Wind Energy Policy was released in 2015.

Target

Target of 5 GW by 2022 and 30 GW by 2030 was announced in 2018.

Objectives of Policy

- Exclusive Economic Zones of the country should be explored and deployment of offshore wind farms should be promoted at these zones.
- The indigenization of offshore wind energy technologies should be encouraged.
- Research and development in the offshore wind energy sector should be promoted.
- We should harness the wind potential at a large scale to reduce carbon emissions.
- Skilled manpower should be created in the field of the offshore energy sector.
- The coastal infrastructure should be developed to cater to the Operation and Maintenance activities in the offshore wind energy sector.

Challenges in Offshore Wind Energy

- Offshore Wind Projects are costlier than Onshore wind Projects
- High cost of installation will lead to higher tariffs
- High cost of operation and maintenance

National Wind-Solar Hybrid Policy

The National Wind-Solar Hybrid Policy was adopted in 2018 to achieve the ambitious target of 175 GW of installed capacity from renewable energy sources by 2022 (100 GW from Solar and 60 GW from Wind).

Hybrid Renewable Energy Park

It is located in Kutch, Gujarat. It has a generation capacity of 30 GW It is the world's largest Solar-Wind Hybrid Park

Aim and Objective

- The main objective is to provide a framework for the promotion of a large grid-connected wind-solar PV hybrid system for optimal and efficient utilization of transmission infrastructure and land, reducing the variability in renewable power generation and achieving better grid stability.
- It also aims to encourage new technologies, methods, and way-outs involving the operation of wind and solar PV plants.

Challenges of Wind Energy

The main challenges of wind energy are as follows

- **Intermittency and Variability:** Wind energy is inherently intermittent and variable, as it depends on the availability and strength of the wind. This variability poses challenges for grid integration and stability, as it requires a backup or storage system to ensure a consistent and reliable power supply.
- **Land and Space Requirements:** Wind turbines require substantial land areas to be installed, particularly for large-scale wind farms. Identifying suitable land areas with high wind resources while minimizing conflicts with other land uses, such as agriculture or ecological conservation, can be a challenge, especially in densely populated regions.
- **Environmental and Ecological Impact:** While wind energy is considered environmentally friendly, the installation and operation of wind turbines can have certain environmental and ecological impacts. These include potential bird and bat collisions, noise pollution, visual impacts, and disturbance to local ecosystems. Proper siting and mitigation measures are essential to minimize these impacts.
- **Grid Integration and Infrastructure Challenges:** Integrating wind power into the existing electricity grid can pose technical challenges. Issues such as grid stability, balancing supply and demand, managing power fluctuations, and upgrading transmission and distribution infrastructure to accommodate increased wind energy generation need to be addressed.
- **High Capital Costs and Financing:** The upfront capital costs of wind turbines and associated infrastructure can be significant. Developing wind farms requires substantial investment, which can pose challenges in securing financing, particularly for smaller developers or in regions with limited access to affordable capital.
- **Maintenance and Operation:** Wind turbines require regular maintenance and operation to ensure optimal performance and longevity. Access to remote or offshore wind turbines for maintenance purposes can be challenging, requiring specialized equipment and skilled technicians.

Green Energy Corridor Project

An initiative of Ministry of New and Renewable Energy, it aims at synchronizing electricity produced from renewable sources, such as solar and wind, with conventional power stations in the grid.

- For evacuation of large-scale renewable energy, Intra State Transmission System (InSTS) project was sanctioned by the Ministry in 2015-16.
- The project is being implemented in these states by the respective State Transmission Utilities (STUs).
- In 2022, the government has approved the Green Energy Corridor - Intra-State Transmission System Phase-II scheme. The transmission infrastructure under the scheme will be setup in seven states namely Gujarat, Himachal Pradesh, Karnataka, Kerala, Rajasthan, Tamil Nadu and Uttar Pradesh.

SMALL HYDRO ENERGY

Hydro Power Projects are classified as large and small hydro projects based on their sizes. In India, hydropower plants with a capacity of 25 MW or below are classified as small hydro.

Status and Potential of Small Hydro Energy in India

- The cumulative capacity of Small Hydro Power in India is 4944.30 MW
- In 2016, the Hydro and Renewable Energy Department assessed the estimated potential of small/mini hydel projects in its Small Hydro Database. The estimated potential was 21133 MW from 7133 sites.
- Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, and Uttarakhand constitute around half of the estimated potential.
- Other Potential sites are Maharashtra, Chhattisgarh, Karnataka, and Kerala.

Benefits associated with Small Hydro Power Projects

- **Renewable and Clean Energy:** Small hydropower projects harness the energy of flowing or falling water to generate electricity. It is a renewable energy source that produces clean electricity without greenhouse gas emissions or air pollutants, contributing to reduced carbon footprints and mitigating climate change.

- **Local Resource Utilization:** Small hydropower projects utilize the energy potential of small rivers, streams, or irrigation canals, often in rural or remote areas. This allows for the utilization of local water resources and reduces the need for long-distance transmission of electricity.
- **Reliable and Stable Power Generation:** Small hydropower plants provide a consistent and reliable source of electricity due to the continuous flow of water. This can help stabilize the power supply, especially in off-grid or remote areas, reducing dependency on expensive and unreliable fossil fuel-based generators.
- **Decentralized Energy Generation:** Small hydropower projects promote decentralized energy generation, allowing communities to become self-sufficient in their electricity needs. This can enhance energy security and reduce vulnerability to disruptions in the main power grid.
- **Low Operation and Maintenance Costs:** Small hydropower projects typically have low operation and maintenance costs, as they require minimal fuel and have simple mechanical components. This makes them economically viable, particularly in remote or rural areas where access to conventional energy sources may be challenging or expensive.
- **Job Creation and Local Development:** The construction and operation of small hydropower projects can create employment opportunities, both directly and indirectly, in the local communities. This includes jobs in project development, installation, operation, and maintenance, contributing to local economic development and poverty reduction.

Do You Know?

The actual implementation of Small Hydro Projects is governed by state policies as a water resource is a state subject. The decision of setting up Small Hydro Projects or their allotment is also taken by the State Government.

Run of the river hydroelectricity project

These are hydroelectric systems that harvest the energy from flowing water to generate electricity. Unlike conventional hydroelectricity projects, it does not require construction of a large dam and reservoir. Instead, it involves redirecting a portion of the river's flow into a designated channel or pipeline. Within this channel, the water passes through turbines, generating electricity, before being released back into the river downstream. Example: Baglihar Hydroelectric Power Project on the Chenab River.

Key differences between Conventional and Run-Of-the-River Hydroelectricity Projects

Conventional Hydro-Electricity Project	Run-Of-the-River Hydroelectricity Project
A large dam is constructed across a river, creating a reservoir by impounding water.	Water is diverted from the river using a weir or a diversion dam, and then channeled through a penstock to a powerhouse where it drives turbines to generate electricity
Create large reservoirs to store water	Limited or no water storage capacity.
	Rely on the natural flow of the river,
Higher Environmental Impact	Lower Environmental Impact
Larger in scale, high capital intensive	Smaller in scale compared to traditional hydroelectric project; less capital intensive
Less dependent on seasonal flow of river	Power output can vary depending on the seasonal flow of the river

WASTE TO ENERGY

The increasing industrialization, urbanization, and changes in the pattern of life have given rise to a generation of increasing quantities of waste. New technologies are being developed to convert waste into energy forms like Biogas/Electricity/Bio-CNG. The agricultural, industrial, and urban wastes of renewable nature are converted into various forms of energy.

Technologies to convert waste into energy

- **Bio-methanation:** It is the anaerobic digestion of organic materials which is converted into biogas. It results in biogas containing mostly methane (60%), carbon dioxide, and other gases. It gives biogas as well as manure as a byproduct. Biogas can be cleaned to remove the carbon dioxide and other substances to produce Bio-CNG.
- **Incineration:** It is a complete combustion of municipal solid waste with the recovery of heat to produce steam that in turn produces power through steam turbines to produce energy. The flue gases are treated and the resultant ash can be used as construction material.

- **Gasification:** It is a process that uses high temperatures (500-1800 degree Celsius) in the presence of oxygen to decompose waste to produce synthetic gas. This gas can be further used for thermal or power generation purposes. This method is used to generate power more efficiently than thermal processes.
- **Pyrolysis:** This process uses heat to break down combustible materials in the absence of oxygen and it produces a gas mixture, bio-oil/tar, and a solid residue. The gas generated is used in boilers to provide heat and it can be used in combustion turbine generators.

The potential of waste to energy

The total estimated energy generation potential from urban and industrial organic waste in India is approximately 5690 MW with contributions from various sectors like

- Urban Solid Waste – 1247 MW
- Urban Liquid Waste – 375 MW
- Paper – 254 MW
- Processing and preserving of meat – 182 MW

Indian Initiatives to Promote waste to energy

Waste to Energy Programme

The implementation of Waste to Energy Programme has been approved under the umbrella scheme of National Bioenergy Programme for the duration of FY 2021-22 to 2025-26. It is a Programme on Energy from Urban, Industrial, and Agricultural wastes/residues.

- **Objective**: The objective of the Waste to Energy Programme is to support the setting up of Waste to Energy projects for the generation of Biogas/ Bio-CNG/Power/Producers or syngas from urban, industrial, and agricultural wastes.
- **Implementing Agency**: Indian Renewable Energy Development Agency (IREDA) will be the implementing agency for this program.

GEF-MNRE-UNIDO Project:

United Nations Industrial Development Organization (UNIDO) is implementing a project named 'Organic Waste Streams for Industrial Renewable Energy Applications in India' in partnership with the Ministry of New and Renewable Energy. This project is funded by Global Environment Facility.

The Project focuses to support energy generation from industrial organic wastes using bio-methanation technology. The industrial priority sectors identified under the project are poultry, cattle, sugar, fruit, vegetable, and food processing.

GIS-based Waste to Energy Generation Potential Mapping Tool:

Its main objective is to facilitate geographical mapping availability of segregated recyclable industrial waste and its potential for energy generation across India.

Challenges of Waste to Energy

Though it holds potential for the future, but not without challenges such as:

- **Waste Composition and Quality:** The composition and quality of waste can vary significantly, making it challenging to ensure consistent and efficient energy production. The presence of contaminants, moisture content, and varying calorific values of different waste streams can impact the combustion process and energy output.
- **Environmental Impact:** Although Waste to Energy can help reduce landfill space and mitigate greenhouse gas emissions, the process still produces emissions and residues that need proper management. The incineration of waste can release pollutants such as nitrogen oxides, sulfur oxides, heavy metals, and particulate matter, which require stringent air pollution control technologies.
- **Public Acceptance and Perception:** Waste to Energy facilities often face opposition from local communities due to concerns about emissions, odor, noise, and potential health risks. Public perception and engagement are crucial in gaining support for these projects and addressing community concerns through transparent communication and effective environmental management.
- **High Capital Costs:** Establishing Waste to Energy facilities requires significant capital investment due to the complex infrastructure and technology involved. The costs associated with waste collection, sorting, pre-treatment, and the installation of energy recovery systems can pose financial challenges for project developers.
- **Regulatory Frameworks and Permitting:** Developing Waste to Energy projects requires complying with numerous environmental regulations and obtaining permits from regulatory authorities. The complex and lengthy approval processes, as well as evolving regulatory frameworks, can introduce uncertainties and delays in project implementation.

- **Waste Hierarchy and Recycling:** Waste to Energy projects should be seen as complementary to recycling and waste reduction efforts rather than a substitute. It is essential to prioritize waste reduction, recycling, and composting initiatives to maximize resource recovery before considering waste as a feedstock for energy generation.
- **Long-term Waste Supply and Contracts:** Waste to Energy projects require a steady and reliable waste supply over their operational lifespan. Ensuring long-term waste supply agreements and waste management contracts can be challenging, as waste generation rates, waste composition, and waste management practices can change over time.

BIO ENERGY

Bioenergy is a form of renewable energy which is sourced through organic material that makes up plants, known as biomass.

- **Bio Mass:** Bio Mass is a renewable organic material that comes from plants and animals. Biomass energy refers to the energy that is produced by living or extinct organisms.
- **Biomass Energy Sources:** The biomass materials used for the generation of power are cotton stalks, bagasse, rice husk, straw, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, sawdust, groundnut shells, etc.

Status of Biomass Energy and its Potential

- According to the Ministry of New and Renewable Energy, about 32% of the total primary energy use in India is still derived from biomass and more than 70% of the country's population depends upon biomass energy for its energy needs.
- The current availability of biomass in India is estimated at about 750 million metric tonnes per year (as per a recent study sponsored by the Ministry of New and Renewable Energy).
- The above study also indicated that agricultural residues can take biomass availability to 230 million metric tons per annum corresponding to a potential of about 28 GW.
- Further, 14 GW of additional power can be generated through bagasse-based cogeneration in sugar mills if they adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.
- Over 800 biomass power and bagasse/non-bagasse cogeneration projects having an aggregate capacity of 10205.61 MW have been installed in the country for feeding power to the grid.
- **Leading states for biomass power projects are** Chhattisgarh, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu.

Biofuels

Biofuels are defined as any hydrocarbon fuel which is produced from an organic matter in a short span of time. Biofuels can be in the form of:

- Solid- wood, manure, etc.
- Liquid – Biodiesel, Bioethanol
- Gaseous – Biogas

These biofuels can be used to replace petrol, diesel, or can be used in addition to diesel and petrol (Ethanol Blending).

Classification of Biofuels:

	1st Generation	2nd Generation	3rd Generation	4th Generation
Sources	These are made from food sources such as sugar, starch, vegetable oil, or animal fats using conventional technology	These are produced from non-food crops or portions of food crops that are not edible and considered as wastes	These are produced from microorganisms like algae	In the production of these fuels, crops that are genetically engineered to take in high amounts of carbon are grown and harvested as biomass
Examples	Ethanol from sugar/ soybean or Bio diesel from soybean	Ethanol, biodiesel from stems, husks, wood chips, and fruit skins	Biofuels produced from aquatic feedstock such as algae	Produced using Bio engineered microorganisms & genetically engineered feedstock

Advantages and Disadvantages of Biofuels

A comparative study of the Advantages and Disadvantages of Biofuels are the following:

Advantages

- Reduce Import Dependency
- Cleaner Environment- One crore lit of E10 saves 20,000 tons of CO_2 emissions.
- Health benefits- It will use used cooking oil for the production of biodiesel.
- Municipal Solid Waste Management through waste-to-energy programs.
- Infrastructural investment in rural areas will take place.
- Employment generation through village-level entrepreneurs and supply chain management.
- It will provide additional income to farmers adding the aim of Doubling Farmer's Income.

Disadvantages

- Biofuels have a high cost of production
- Fertilizers can be used to increase the production of crops for maximum benefit.
- It may motivate farmers to grow particular crops which will lead to the practice of monoculture.
- It may lead to the issue of fuel vs food debate.
- The production processes of biofuels use lots of water and oil which may lead to the problem of water pollution.
- These biofuels are less suitable for use in low temperatures.
- It may bring changes in land use due to damage caused to local habitats and problems of deforestation.

Major Biofuels

Bioethanol: It is ethyl alcohol or ethanol which is obtained by sugar fermentation processes. It is the main biofuel used as a substitute for petrol. Ethanol is a clear colorless liquid and it is biodegradable and less toxic. It is a high-octane fuel.

Bio-Diesel: It can be made from plant oil, animal oil, or cooking oil. It emits less or no number of harmful gases. In India, Bio-diesel is produced primarily from imported palm stearin oil. In National Biofuel Policy, used cooking oil has been identified as a potential raw material for biodiesel production.

Biogas: It is produced from the breakdown of bio-degradable organic matter like cattle dung, biomass from farms, kitchens, night soil, etc. through anaerobic digestion in biogas plants. Biogas is a mixture of gases- Primarily Methane (CH$_4$) and Carbon Dioxide and traces of Hydrogen Sulfide, and moisture. Biogas has a calorific value of about 5000 kcal per m^3. The digested slurry produced from biogas plants is used as organic manure in agriculture.

Bio-hydrogen: It can be produced with the help of several processes like biological fermentation, gasification, and pyrolysis.

Biobutanol: It can be produced with the production methods of bioethanol like the fermentation of starch. It can be used as an addition to diesel.

Initiatives for Promotion of Biofuels

National Policy on Biofuels – 2018

The National Policy on Biofuels – 2018 was notified by the Ministry of Petroleum and Natural Gas in supersession of National Policy on Biofuels, 2009. It is implemented by National Biofuel Coordination Committee chaired by Petroleum and Natural Gas Minister.

Key Features

- It categorizes biofuels as-
  - Basic Biofuels- 1st generation biodiesel and bioethanol
  - Advanced Biofuels- Second Generation ethanol, Municipal Solid Waste to drop-in-fuels, 3G biofuels, bio-CNG, etc.
- It expands the scope of raw material for ethanol production by allowing the use of sugarcane juice, sugar beet, sweet sorghum, corn, cassava, damaged food grains like wheat, broken rice, and rotten potatoes.
- It allows the use of surplus food grains for the production of ethanol for blending with petrol with the approval of the National Biofuel Coordination Committee.
- It indicates a viability gap funding scheme for 2G ethanol Bio refineries.
- It encourages the setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, used cooking oil, and short gestation crops.

Recent Amendments in 2022:

- **Target:** The target of 20% ethanol blending in petrol has been advanced to Ethanol Supply Year (ESY) 2025-26 from earlier 2030.
- **Export Promotion:** Export of biofuels in certain cases approved.
- **Use of Feedstock:** Use of more feedstocks for production of biofuels allowed.

- **Production under "Make in India":** Production of biofuels, under the Make in India program, by units located in Special Economic Zones (SEZ)/ Export Oriented Units (EoUs),
- **Changes in National Biofuel Coordination Committee (NBCC):** New members to the NBCC to be added.

> **DO YOU KNOW?**
>
> First Greenfield grain-based ethanol plant was set up in Purnia, Bihar

Ethanol Blended Petrol (EBP) programme:

It seeks to achieve blending of Ethanol with Petrol with a view to reduce pollution, conserve foreign exchange and increase value addition in the sugar industry. The Ethanol blending target of 20% blending in petrol has been revised to ESY 2025-26 from 2030.

Pradhan Mantri JI-VAN Yojana, 2019:

Pradhan Mantri Jaiv Indhan- Vatavaran Anukool Fasal Awasesh Nivaran Yojana was launched in 2019 by the Indian Government with the following targets:

- To provide financial assistance to integrated bio-ethanol projects for setting up second generation 2G ethanol projects in the country using lignocellulosic biomass and other renewable feedstock.
- A maximum financial assistance of Rs 150 crore per project for commercial projects and Rs 1.5 crore per project for demonstration projects has been prescribed for promoting commercial viability and also promoting R&D for the development and adoption of technologies in the production of 2G ethanol.

Biogas Power Generation (Off-Grid) and Thermal energy application Program (BPGTP):

It is being implemented by the Agricultural and Rural Development Departments of the States and Dairy Cooperatives. Further, It is also implemented through the State Renewable Energy Agencies, Biogas Development and Training Centers, Khadi and Village Industries Commission, and National Dairy and Development Board.

Objectives:

- To promote biogas based Decentralized Renewable Energy Sources of power generation, in the capacity range of 3 kW to 250 kW or thermal energy for heating/cooling applications from the biogas generation produced from Biogas plants of 30 M3 to 2500 M3 size.
- Creation of biogas plant facilities for Farmers/Dairy Farmers//Individual Organizations in Rural areas.

New National Biogas and Organic Manure Programme (NNBOMP)

It was introduced by the Government of India in 2018. It has the following **objectives:**

- To provide clean cooking fuel for kitchens, lighting and meeting other thermal and small power needs of farmers/dairy farmers/users including individual households and to improve organic manure system
- To mitigate drudgery of women and time-saving for them for other livelihood activities
- To improve sanitation in rural and semi-urban areas including linking sanitary toilets with cattle dung biogas plants
- To provide biogas plant produced slurry as organic enriched bio manure
- To help in combating and reduction in causes of climate change by preventing emissions of GHGs.

National Bio Energy Program

The Ministry of New and Renewable Energy has notified the National Bio Energy Program in 2022. It has continued the National Bio Energy Program for the period from FY 2021-22 to 2025-26. It will be implemented in two phases.

It will comprise of the following sub-schemes:

- **Waste to Energy Program** (Program on Energy from Urban, Industrial and Agricultural Wastes) to support setting up of large Biogas, BioCNG and Power Plants.
- **Biomass Program** (Scheme to support manufacturing of Briquettes & Pellets and promotion of Biomass (non-bagasse) based cogeneration in industries) to support setting up of pellets and briquettes for use in power generation and non-bagasse-based power generation projects.
- **Biogas Program** to support setting up of family and medium size biogas plants in rural areas.

Sustainable Alternative Towards Affordable Transportation (SATAT) Scheme

This scheme was launched in Oct 2018 under the Ministry of Petroleum and Natural Gas. It has the following objectives:

- It was taken up to extract economic value from biomass waste in the form of Compressed Biogas and bio manure.
- It envisages the setting up of 5000 Compressed Biogas plants for the production of 15 million Metric Tons per annum of Compressed Biogas by 2023-24.

Galvanizing Organic Bio-Agro Resources (GOBARdhan) Scheme

GOBARdhan was launched in 2018 to ensure cleanliness in villages. It has the following features:

- It aims to convert bio-waste to improve the lives of villages. It will provide economic and resource benefits to farmers and households.
- Department of Drinking Water and Sanitation is implementing this with the collaboration of concerned Departments/Ministries/State Governments and Public and Private sector institutions and village communities to make it a Jan Andolan.
- It will help rural women in the improvement of their health, reduce in import of crude oil, give a boost to entrepreneurship, and promote organic farming.

Objectives:

- To support villages safely manage their cattle waste, agricultural waste, and then in the long run all organic waste
- To support communities so that they can use decentralized systems to convert their cattle and organic waste to wealth
- Promotes environmental sanitation and reduces vector borne diseases
- To convert organic waste to biogas and fertilizer

METHANOL

Methanol is a low-carbon and hydrogen carrier fuel that can be produced from high ash coal, CO2 from thermal power plants, agricultural residue, and natural gas. It is the bridge to the dream of a complete Hydrogen Based Fuel System. It is a scalable and sustainable fuel.

Advantages of Methanol

- It can replace both petrol and diesel in the transport sector (road, rail and marine).
- Blending of 15% methanol in gasoline can result in at least 15% reduction in the import of gasoline/crude oil.
- It would bring down GHG emissions by 20% in terms of particulate matter, NOx and SOx which will improve the urban air quality.
- It will also create close to 5 million jobs through methanol production and distribution services.

Status and Potential

- Assam Petrochemicals Ltd has commissioned a methanol plant in Dibrugarh with a capacity of 500 tonnes per day.
- India's first Coal-to Methanol Plant has been inaugurated at Hyderabad. It is indigenously designed, developed, and installed by BHEL with 0.25 tonnes per day capacity. It is producing methanol with a purity of more than 99% from high-ash Indian coal.
- Methanol Economy Program is NITI Aayog's program which is aimed at reducing India's oil import bill, GHG emissions, and converting coal reserves and municipal waste into methanol.

NITI Aayog road map for Methanol Economy

NITI Aayog is at the forefront to increase the use of Methanol in the economy and hence prepared a comprehensive roadmap, that includes the following provisions:

- Production of methanol from Indian high ash coal using indigenous technology.
- Biomass, Stranded gas, and Municipal Solid Waste will be used for methanol production.
- Utilization of methanol as well as Di-methyl ether in the transportation sector.
- Utilization of methanol and Di-methyl ether as domestic cooking fuel.
- Utilization of methanol and Di-methyl ether in fuel cell applications in Marines, Gensets, and Transportation.

HYDROGEN ENERGY

Hydrogen is a colorless, odorless, flammable gaseous substance and it is the most abundant element in the universe. It has the potential to substitute conventional fuels and reduce CO2 emissions. Hydrogen energy has the highest energy content by weight and it has the lowest energy content by volume.

Different Forms of Hydrogen

Hydrogen have been categorized into different forms depending upon the source, such as

Different Forms of Hydrogen

Green Hydrogen:

It is a form of hydrogen that is produced by splitting water by electrolysis using clean electricity from surplus renewable energy sources like solar or wind power. Water will split into hydrogen and oxygen through an electrochemical reaction.

Grey Hydrogen:

It is produced the same as blue hydrogen from natural gas and heated water. But, the carbon capture and storage process is not used in this production method.

Pink Hydrogen:

This type of hydrogen is produced through an electrolysis process with the use of nuclear power. It can also be referred to as purple or red hydrogen.

Yellow Hydrogen:

It is a form of hydrogen that is produced through electrolysis using solar power.

Blue Hydrogen:

It is produced from natural gas in a steam reforming process in which natural gas is treated with heated water. The output of this is hydrogen and carbon dioxide. This carbon is trapped through a carbon capture and storage process.

Black or Brown Hydrogen:

It is a form of hydrogen that is produced from fossil fuels using a gasification process. Black coal or lignite is used in the hydrogen-making process.

Turquoise Hydrogen:

It is a form of hydrogen that is produced by the use of the methane pyrolysis process in which the output is hydrogen and solid carbon.

White Hydrogen:

It is naturally occurring hydrogen found in underground deposits and created through fracking.

Initiatives to Promote Hydrogen Energy

National Green Hydrogen Mission

Aim: The mission aims to provide a comprehensive action plan for establishing a Green Hydrogen ecosystem and catalyzing a systematic response to the opportunities and challenges of this sunrise sector.

Objectives

- To make India the Global Hub for the production, usage, and export of Green Hydrogen and its derivatives.
- To contribute to India's aim to become Aatmanirbhar through clean energy and serve as an inspiration for the global clean energy transition.
- To reduce dependence on fossil fuel imports and decarbonize the economy.
- To enable India to assume technology and market leadership in Green Hydrogen.

Significance

- It can enable the utilization of domestically abundant renewable energy resources across regions, seasons, and sectors, feeding multiple usage streams, either as a fuel or as an industrial feedstock.
- It can directly replace fossil fuel-derived feedstocks in petroleum refining, fertilizer production, steel manufacturing, etc.
- Hydrogen-fueled long-haul automobiles and marine vessels can enable the decarbonization of the mobility sector.
- It can be useful as a versatile energy carrier for meeting the energy requirements of remote geographies, including islands, in a sustainable manner.

Likely Outcomes by 2030:

- Development of green hydrogen production capacity of at least 5 million Metric Tonne per annum with an associated renewable energy capacity addition of 125 GW
- Over Rs. 8 Lakh Crore in total investments
- Creation of over 6 Lakh jobs
- Cumulative reduction in fossil fuel imports over Rs. 1 Lakh crore
- Abatement of nearly 50 MMT of annual GHGs emissions.

Phased Approach

The policy is designed to be implemented in two phases, such as

1. **Phase 1 (2022-23 To 2025-26):**
   - The focus will be on creating demand while enabling adequate supply by increasing the domestic electrolyzer manufacturing capacity.
   - A bouquet of incentives aimed at indigenization of the value chain and increasing Green Hydrogen production will be developed.

- It will lay the foundation for future energy transitions in other hard-to-abate sectors by creating the required R & D impetus.
- It will establish a framework of regulations and standards to facilitate the growth of the sector and enable harmonization and engagement with international norms.

1. **Phase II (2026-27 to 2029-30):**

- The potential of commercial-scale Green Hydrogen based projects in steel, mobility, shipping, railways, and aviation sectors will be explored.

Key Programs

The following key programs have been launched under the Mission to achieve the expected outcomes:

- **Strategic Interventions for Green Hydrogen Transition Program (SIGHT)**
- Under this, two financial incentive mechanisms will be provided-
    - Targeting domestic manufacturing of electrolyzers
    - Production of Green Hydrogen
- **Green Hydrogen Hubs**
- Under this, regions capable of supporting large-scale production and/or utilization of Hydrogen will be identified and developed as Green Hydrogen Hubs.
- **Strategic Hydrogen Innovation Partnership (SHIP)**
- It is a public-private partnership framework for R&D that will be facilitated under this mission.

Challenges:

- **Cost:** The production of hydrogen through electrolysis is currently more expensive compared to conventional fossil fuel-based energy sources. The cost of electrolyzers, which are used to produce hydrogen from water, needs to be reduced, and the efficiency of the process needs to be improved to make green hydrogen cost-competitive with other forms of energy.
- **Infrastructure:** The establishment of a robust hydrogen infrastructure is a significant challenge. This includes building hydrogen production facilities, storage systems, and distribution networks. Developing the necessary infrastructure to produce, store, and transport hydrogen safely and efficiently requires substantial investment.
- **Scalability:** Scaling up hydrogen production to meet the energy demands of various sectors is a challenge. Large-scale electrolysis facilities and renewable energy sources need to be deployed to ensure sufficient hydrogen production capacity. The intermittent nature of renewable energy sources also presents challenges in matching hydrogen production with energy availability.
- **Storage and Transportation:** Hydrogen has a low energy density compared to traditional fossil fuels, making its storage and transportation complex. It requires compression, liquefaction, or other techniques to increase its density and enable efficient storage and transportation. These techniques need to be further developed and optimized to reduce costs and improve safety.
- **Safety:** Hydrogen is highly flammable and has a wide flammability range. Ensuring the safe handling, storage, and transportation of hydrogen is crucial. Safety standards and regulations need to be established and implemented to mitigate risks and build public confidence in hydrogen technologies.
- **Technology Maturity:** While hydrogen technologies have made significant progress, they are still relatively less mature compared to conventional energy technologies. Further research and development efforts are required to improve the efficiency, durability, and reliability of hydrogen production, storage, and utilization technologies.

DO YOU KNOW?

- Oil India Limited commissioned India's First 99.99% pure Green Hydrogen pilot plant at its Jorhat Pump Station in Assam.
- GAIL (INDIA) Limited began India's maiden project of mixing hydrogen into the natural gas system at Indore, Madhya Pradesh.

Hydrogen Valley Platform

The Hydrogen Valley platform is a joint initiative by the Clean Hydrogen Joint Undertaking and Mission Innovation. It is a global collaboration platform for all information on large-scale hydrogen flagship projects and aims to facilitate a clean energy transition by promoting the emergence of integrated hydrogen projects along the value chain as well as by raising awareness among policymakers.

In India, the Department of Science and Technology has committed to facilitating the delivery of three clean hydrogen valleys by 2030.

Hydrogen Fuel Cells

Under this form of energy, the electrochemical energy is converted into electrical energy to be used for various purposes. It follows a simple process, such as:

- Hydrogen Fuel Cell uses hydrogen as a fuel in an electrochemical process.
- Hydrogen is fed to the anode of the fuel cell and air is fed to the cathode of the fuel cell.
- The electrons from hydrogen go through an external circuit, creating a flow of electricity.
- The chemical energy of hydrogen is used to generate electricity in a clean and efficient manner.
- Water and steam are the only byproducts.

Fuel Cell Electric Vehicles

Fuel Cell Electric Vehicles (FCEVs) are a type of zero-emission vehicle that uses hydrogen as a fuel to produce electricity through a chemical reaction in a fuel cell. FCEVs offer long driving ranges, and quick refueling times, and emit only water vapor as their byproduct. They hold promise for decarbonizing transportation and reducing dependence on fossil fuels, contributing to a more sustainable and cleaner future for mobility.

Advantages and Disadvantages of Hydrogen Fuel Cells

Advantages	Disadvantages
• It is environment friendly and does not emit harmful emissions • High energy density • Rockets can also use this as a fuel • It is renewable and can be produced again and again • Helps in achieving energy security and fulfilling de-carbonization goals	• Lack of infrastructure for the growth of hydrogen fuel cell powered vehicles. • These vehicles are quite expensive than conventional fuel vehicles. • Safety is also a major concern as both hydrogen and oxygen are flammable. • It has the problem of storage.

GEOTHERMAL ENERGY

Geothermal Energy is an energy source that is stored in the form of heat beneath the earth's surface. It is a clean, renewable, sustainable, carbon-free, continuous, and environment-friendly energy source.

Types of Geothermal Power Plants

There are basically three types of GPP based on the process they are involved in generating energy, such as

- **Dry steam plants:** They use geothermal hot steam (> 235 degree Celsius) directly from the reservoir. It goes directly through a pipe to a turbine to spin a generator which produces electricity.
- **Flash Steam Plants:** These plants use high-pressure hot water (>182 degree Celsius) to produce steam.
- **Binary Cycle Plants:** In these plants, hot geothermal fluids are passed through one side of a heat exchanger to heat a working fluid (Iso-butane or Iso-pentane) in a separate pipe. This fluid is vaporized and passed through a turbine to generate electricity.

Distribution in India

Geothermal resources in India have been mapped by the Geological Survey of India (GSI). A broad estimate suggests that there could be 10 GW of geothermal power potential per the Ministry of New and Renewable Energy (MNRE) in 2021.

The major areas for geothermal energy in India are

- **The Himalayas:** J&K, HP, and Sikkim; PUGA and Chhumathang hot spring in J&K and Manikaran & Beas valley in HP. Satluj and spiti valley.
- **Sohana:** Haryana, Rajasthan.
- **Son-Narmada-Tapi (SONATA):** MP, Chhattisgarh and Damodar valley basin in Jharkhand; Tattapani spring in Chhattisgarh.
- **Cambay:** Lasundra, Tuwa, and Chhabsar, mainly in Gujarat and some parts of Rajasthan
- **Godavari:** AP
- **Mahanadi:** Orissa, Taptapani Spring in Orissa.
- Andaman-Nicobar region
- Salbardi region, Unkeshwar and Konkan geothermal provinces in Maharashtra
- Tapoban geothermal field, Chamoli, Uttarakhand, and Alaknanda Valley

Geothermal Power Plant at Puga, Ladakh:

It is India's first and World's highest Geothermal energy plant. ONGC will drill 1,000-meter-deep wells to run a 1 MW power plant on a pilot basis.

Significance:

- It will provide power to far-flung areas in Ladakh.
- It can be used for green housing to reduce the import of vegetables.
- It will boost tourism.
- It will help in offsetting the carbon footprint

Advantages and Disadvantages of Geothermal energy

Advantages	Disadvantages
• It is a renewable and environment-friendly power source that has a low carbon footprint.	• The locations where geothermal energy is available are restricted.
• Geothermal energy source has huge potential worldwide.	• It incurs high costs for the exploration and for setting up of plants.
• It is a reliable and sustainable source of energy.	• There is always the danger of the release of harmful gases from Earth's interior.
• It is relatively less expensive than conventional energy sources. Unlike solar and wind, it is available 24 hours a day and 365 days a year. It emits around 80% less greenhouse gases compared to coal and oil.	• The digging might trigger earthquakes due to alterations in Earth's structure.

OCEAN ENERGY

It is the energy produced from tidal streams, ocean waves, temperature gradients, and salinity gradients. It is an inexhaustible source of renewable energy.

Forms of Ocean Energy

- **Wave Energy**: It is generated by the movement of a device either floating on the surface or moored to the ocean floor by the force of the ocean waves
- **Tidal Energy:** It is generated by the potential energy created by the difference in water level from low tide and high tide. Tidal energy is still in Research & Development (R&D) phase and has not been implemented on a commercial scale in India.
- The potential areas with low/medium tidal wave strength are in the Gulf of Khambhat, Gulf of Kutch & southern regions in Gujarat, Palk Bay- Mannar Channel in Tamil Nadu, and Hooghly River, South Haldia & Sundarbans in West Bengal.
- **Current Energy**: The ocean current helps in the capture of kinetic energy and the movement of the ocean current rotates the blades and generates electricity.
- **Ocean Thermal Energy Conversion:** It uses ocean temperature differences from the surface to depths to harness energy.

Potential in India

India has a long coastline and in addition, 4th largest Exclusive Economic Zone in the world, which provides huge potential to generate Ocean Energy.

- India has a potential of 41,000 MW and 12,500 MW from Wave Energy and Tidal Energy respectively (As per a study conducted by IIT Madras).
- The promising sites for ocean energy are the Gulf of Khambhat & Gulf of Kutch, Sundarbans, and the western coast of Maharashtra, Goa, Karnataka, Kerala, and Kanyakumari.

Challenges associated with Ocean Energy

- **Technology Development:** The development of reliable and efficient ocean energy conversion technologies is a significant challenge. Designing devices that can withstand harsh marine environments, such as corrosion, biofouling, and extreme weather conditions, while efficiently capturing and converting ocean energy into electricity requires ongoing research and development efforts.
- **Cost and Economics:** Ocean energy technologies are currently more expensive compared to conventional energy sources. The high upfront costs of equipment, installation, maintenance, and grid connection pose economic challenges. Reducing the overall cost of ocean energy systems through technological advancements, economies of scale, and streamlined deployment processes is essential for their commercial viability.
- **Environmental Impact:** Deploying Ocean energy devices and infrastructure may have environmental impacts on marine ecosystems. These impacts include underwater noise, changes in water flow patterns, and potential risks to marine wildlife, such as fish and marine mammals. Understanding and mitigating these potential environmental impacts are critical for the sustainable development of ocean energy projects.
- **Grid Integration and Infrastructure:** Connecting Ocean energy systems to the power grid can be challenging, especially in remote or offshore locations. The integration of intermittent energy sources into the existing grid infrastructure requires careful planning and investment in grid connectivity, transmission, and energy storage solutions to ensure a stable and reliable power supply.

- **Resource Variability and Predictability:** The availability and predictability of ocean energy resources can vary depending on geographic location and seasonal variations. Tides, waves, and currents are influenced by complex oceanographic factors, making it challenging to accurately predict energy production. Developing accurate resource assessment methodologies and advanced forecasting techniques can help optimize the design and operation of ocean energy systems.

DO YOU KNOW?

IIT Madras Researchers developed 'Sindhuja' which generates Electricity from Sea Waves

- 'Sindhuja-I,' means **'generated from the ocean.'**
- **Location**: The device is located in Tuticorin, Tamil Nadu.
- **Current Production:** 100 watts of energy.
- **Target**: Generate 1 MW power from ocean waves in the next three years.
- The Device is targeted towards remote offshore locations that require reliable electricity and communication.
- **'Wave Energy and Fluids Engineering Laboratory' (WEFEL):** It is a state-of-the-art laboratory at IIT Madras which is associated with the research.

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INTRODUCTION TO SUSTAINABLE DEVELOPMENT

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Although the concept took shape in the eighties, it was in the last decade of the 20th century that Sustainable Development developed into effective action around the world. It has now become the new paradigm for economic development for both the rich and the poor countries.

CONCEPT OF DEVELOPMENT AND SUSTAINABILITY

Development

Development is a dynamic process that fosters growth, progress, positive change and the incorporation of various aspects such as physical, economic, environmental, social, and demographic components. It can also be defined as a socioeconomic state inside a country in which the rational and sustainable use of natural resources and systems meets the demands of its people. Development entails considerable changes in social structures, attitudes, and institutions, as well as the reduction of inequality and the abolition of absolute poverty.

Sustainability

The ability to retain a specific entity, outcome, or process over time is referred to as sustainability. The improvement and maintenance of a healthy economic, ecological, and social framework for human progress is commonly referred to as sustainability in the development literature. Several definitions of sustainability have been proposed, including efficient and equitable resource distribution, a dynamic balance between people and environment, and the ability to meet human needs without diminishing productive resources. Overall, sustainability emphasizes the need of human activities drawing on natural resources in ways that enable human progress while neither depleting nor harming the environment.

SUSTAINABLE DEVELOPMENT

Sustainable development has become a common word in development debates, with diverse interpretations and implications. At its essence, sustainable development refers to a sort of development that can last indefinitely or for a set amount of time. The term is made up of two concepts, "sustainable" and "development," each of which has been defined differently from different angles. While there are numerous definitions of sustainable development, the Brundtland Commission Report's definition is the most commonly cited. It states that sustainable development should meet the needs of the current generation without jeopardizing future generations' ability to meet their own needs.

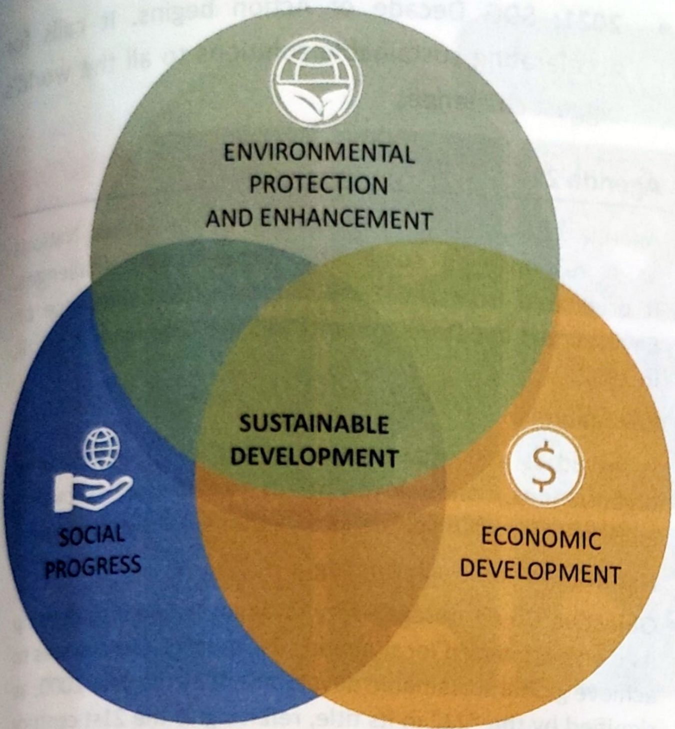
Key Features of Sustainable Development

The central aspects of sustainable development are the following:

- It is a goal to be reached rather than an initiative or a project to be implemented.
- Strategies, approaches and tools are needed to help achieve this goal
- It considers both the living and non-living resource base with regard to conservation.
- It focuses on the current and future stocks of natural, social and economic capital, and processes or functions which link environmental, social and economic systems.
- It is concerned that future generations do not face reduced access to resources and development options, compared to the present generation.

Economic, Social and Environmental Sustainability

The concept of Sustainable Development rests on three pillars: **economic sustainability, social sustainability, and environmental sustainability**.



Sustainable Development

- **Economic sustainability:** It means producing enough to meet current consumption levels without compromising the ability to meet future needs. In the past, economists assumed that natural resources were unlimited and relied on the market to allocate resources efficiently. They also believed that economic growth would result in the technology to replenish natural resources. However, it is now recognized that natural resources are finite, and not all of them can be replenished or renewed. The scale of the economic system has stretched the natural resource base, leading to a reconsideration of traditional economic ideas and questions the feasibility of uncontrolled growth and consumption.
- **Social sustainability**: It involves concepts such as equity, empowerment, accessibility, participation, cultural identity, and institutional stability. It emphasizes the importance of people in development and aims to alleviate poverty through a social system that does not harm the environment or cause economic instability. The theory of social sustainability suggests that poverty reduction should occur within the society's existing environmental and economic resources.
- **Environmental sustainability:** It focuses on maintaining the natural environment's productivity and resilience to support human life. It is concerned with the integrity of ecosystems and the carrying capacity of the environment. Natural resources should be used sustainably as inputs for economic activities and as a waste disposal sink. To achieve this, resources must be harvested at a rate that allows for regeneration, while waste must be emitted at a rate that the environment can absorb. Earth systems have limits or boundaries that must be respected to maintain balance.

History of Sustainable Development

The notion of sustainable development served as the foundation for the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The summit was the first international attempt to formulate action plans and strategies for moving towards a more sustainable pattern of growth. Sustainable development was proposed as a solution to the Brundtland Commission's report Our Common Future in 1987. The concept of sustainable development received its first major international recognition in 1972 at the UN Conference on the Human Environment held in Stockholm.

- **1972:** The United Nations holds the first major conference on the environment, known as the United Nations Conference on the Human Environment or the Stockholm Conference. It emphasizes the interdependence between human well-being and the environment.

United Nations Environment Programme (UNEP)

It is a specialized agency of the United Nations that focuses on environmental issues and sustainable development. It is headquartered in Nairobi, Kenya.

Background: It was established in 1972, following the United Nations Conference on the Human Environment held in Stockholm.

Functions:

- UNEP serves as the leading global authority on environmental matters.
- It provides guidance, coordinate efforts, and promotes cooperation among nations to address environmental challenges.
- It hosts the secretariats of several multilateral environmental agreements and research bodies. These include: the Convention on Biological Diversity (CBD), the Minamata Convention on Mercury, The Basel, Rotterdam and Stockholm Conventions, the Convention on International Migratory Species and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) etc.

- It is one of several implementing agencies for the Global Environment Facility (GEF) and the Multilateral Fund for the Implementation of the Montreal Protocol.
- It assigns specific years to topics to raise awareness and engagement.
- **World Environment Day:** It is led by UNEP and held annually on 5 June since 1973. It seeks to raise awareness on various environmental issues. The 2023 theme for World Environment Day is "Solutions to plastic pollution"
- **1983:** The World Commission on Environment and Development, also known as the **Brundtland Commission,** is established. It releases its report in 1987 titled "**Our Common Future**," which popularizes the definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- **1992:** The United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, takes place in Rio de Janeiro, Brazil. It leads to the adoption of **Agenda 21,** and the establishment of key international agreements, including the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD).
- **2000:** The Millennium Development Goals (MDGs) are adopted by the United Nations, outlining eight specific goals to be achieved by 2015, primarily focused on poverty reduction and basic human needs.
- **2012:** The United Nations Conference on Sustainable Development, also known as Rio+20, is held in Rio de Janeiro. It results in the adoption of the outcome document "The Future We Want," which reaffirms commitments to sustainable development and calls for the development of Sustainable Development Goals (SDGs).
- **2015:** The United Nations General Assembly adopts the 2030 Agenda for Sustainable Development, which includes the Sustainable Development Goals (SDGs). The SDGs consist of 17 goals and 169 targets, addressing a wide range of social, economic, and environmental issues, and aim to be achieved by 2030.
- **2016:** Agenda 2030 begins to take effect with a term of 15 years.
- **2020:** The COVID-19 pandemic poses significant challenges to sustainable development worldwide, exposing and exacerbating existing inequalities and vulnerabilities.
- **2021:** SDG Decade of Action begins. It calls for accelerating sustainable solutions to all the world's biggest challenges

Agenda 21

Agenda 21 is an action plan created by the United Nations as a response to sustainable development challenges. It originated from the Earth Summit (UN Conference on Environment and Development) held in Rio de Janeiro, Brazil, in 1992.

Key features:

It served as a framework for the UN, other international organizations, and governments worldwide, providing guidelines for action at the local, national, and global levels.

Nature: It is not legally binding.

Objective: To encourage every local government to develop its own customized local Agenda 21. Initially, the aim was to achieve global sustainable development by the year 2000, as signified by the "21" in its title, referring to the 21st century target.

Scope: It included a broad spectrum of issues, including environmental protection, social equity, and economic progress.

SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals (SDGs) consist of 17 interconnected global goals aimed at transforming the world to achieve a more sustainable future for all. In order to provide a roadmap for building a better world, they were developed as part of the United Nations 2030 Agenda for Sustainable Development. The 17 SDGs are structured around the five pillars of the 2030 Agenda: People, Planet, Prosperity, Peace, and Partnerships.

Each of the 17 SDGs, aspires to advance global reductions in poverty and climate change while enhancing economic growth, education, and health. The SDGs, according to the United Nations, aim to "protect the planet, and improve the lives and prospects of everyone, everywhere."

The SDGs serve as a global guide for addressing each of these goals, with most countries facing crises in these areas that can only be tackled through global collaboration and cooperation. Achieving the SDGs requires the world to work together as a single global community.

Difference between MDG & SDG

Basis	MDG	SDG
Scope	The MDGs were established by the United Nations (UN) in 2000 and were in effect until 2015. They consisted of eight goals that primarily focused on eradicating extreme poverty and improving social indicators, such as education, health, and gender equality.	The SDGs, also known as the Global Goals, were adopted by the UN in 2015 and have a broader scope. They consist of 17 goals and 169 targets, aiming to address a wider range of issues beyond poverty, including environmental sustainability, economic growth, social inclusion, and governance.
Focus	The MDGs were primarily focused on developing countries, particularly those in the Global South, with a strong emphasis on poverty reduction and basic human needs.	The SDGs are universal in nature, applying to all countries, including both developed and developing nations. They address not only poverty but also other global challenges, such as climate change, inequality, sustainable consumption, and peace and justice.
Approach	The MDGs followed a more top-down approach, with global targets and indicators set by the UN and implemented by individual countries. Progress was primarily measured through national-level statistics and indicators.	The SDGs take a more participatory and bottom-up approach, involving various stakeholders, including governments, civil society, businesses, and academia, in their implementation. They recognize the importance of local context and encourage multi-stakeholder partnerships and collaboration.
Integration	The MDGs were relatively siloed, focusing on specific areas such as health, education, and gender. There was limited integration and consideration of the interlinkages between different goals.	The SDGs aim for greater integration and interconnectedness among the goals. They recognize that addressing one goal can have positive or negative impacts on other goals, and thus advocate for a holistic and integrated approach to sustainable development.

SIGNIFICANCE OF SUSTAINABLE DEVELOPMENT

Sustainable development is of significant importance for both the present and future generations. It is a holistic approach that aims to balance environmental protection, social progress, and economic prosperity. Below given are some of the reasons why sustainable development is significant:

- **Environmental Preservation:** Sustainable development recognizes the finite nature of natural resources and promotes their responsible use.

It seeks to minimize environmental degradation, conserve biodiversity, and address climate change. By adopting sustainable practices, we can protect ecosystems, safeguard natural resources, and ensure their availability for future generations.

- **Social Equity and Inclusivity:** Sustainable development emphasizes the need for social progress and equity. It aims to eradicate poverty, reduce inequalities, and promote inclusive societies. By addressing social issues such as access to education, healthcare, clean water, and sanitation, sustainable development aims to improve the quality of life for all individuals, particularly the marginalized and vulnerable populations.
- **Economic Prosperity:** Sustainable development recognizes the interdependence between economic growth and environmental and social well-being. It promotes the development of an inclusive and resilient economy that ensures long-term prosperity while minimizing negative impacts. By integrating sustainability principles into business practices, it encourages innovation, resource efficiency, and the development of sustainable industries, leading to economic growth and job creation.
- **Intergenerational Responsibility:** Sustainable development emphasizes the idea of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It calls for responsible decision-making and long-term thinking, taking into account the impacts of our actions on future generations. By adopting sustainable practices, we can ensure a sustainable and thriving world for future inhabitants.
- **Global Collaboration:** Sustainable development requires international cooperation and collaboration. It recognizes that environmental and social challenges transcend national boundaries and that solutions require collective efforts. Through partnerships, knowledge sharing, and collaborative action, sustainable development promotes global unity and the exchange of best practices to address common challenges.
- **Resilience to Risks and Uncertainties:** Sustainable development enhances societal and environmental resilience. By diversifying energy sources, promoting sustainable agriculture, and investing in disaster preparedness, it helps communities and ecosystems better withstand shocks and uncertainties, such as natural disasters, economic crises, or climate change impacts.

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK

It was established In 2012 by UN Secretary-General, which is an independent non-profit organization in the United States and a non-profit Association in France

- **Mission:** To promote integrated approaches to implement the Sustainable Development Goals and the Paris Agreement on Climate Change, through education, research, policy analysis, and global cooperation
- **Members:** 1,700 members in 50 networks across 144 countries

About India–UN Sustainable Development Cooperation Framework (UNSDCF) 2023–27

Aim: To align the four pillars of the 2030 Agenda—People, Prosperity, Planet and Participation—with India's national priorities.

Six outcome areas:

- Health and well-being
- Nutrition and food
- Quality education
- Economic growth and decent work
- Environment, climate, wash and resilience
- Empowering people, communities, and institutions
- The framework is the single most important instrument capturing the entirety of 26 UN entities' plans and programmes in India

SUSTAINABLE CITIES INTEGRATED APPROACH PILOT (SCIAP) PROJECT

The project aims to integrate sustainability strategies into urban planning and management at the city level, fostering a conducive environment for investments in green infrastructure. This investment will help decrease greenhouse gas emissions, enhance service provision, and elevate the overall quality of life for all residents.

- **Implementation:** By UNIDO with inputs from UN Habitat and in partnership with Ministry of Housing & Urban Affairs
- **Covers five pilot cities:** Jaipur, Mysore, Vijayawada, Guntur and Bhopal
- It is funded Global Environment Facility.
- **Aim:** To develop an Urban Sustainability Assessment Framework (USAF) for spatial planning in India
- **The general framework of the project is:**
  - Sustainable urban planning and management (in partnership with UN HABITAT)

- Investment projects and technology demonstration
- Partnership and knowledge platform

About UN-Habitat

- **Established:** In 1978 as an outcome of the First UN Conference on Human Settlements and Sustainable Urban Development (Habitat I) held in Vancouver, Canada, in 1976.
- **Aim:** To promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all.
- **Headquarters:** United Nations Office at Nairobi, Kenya.
- **Member of the United Nation Development Group:** The mandate of UN-Habitat derives from the Habitat Agenda, adopted by the United Nations Conference on Human Settlements (Habitat II) in Istanbul, Turkey, in 1996.
- **Twin goals of the Habitat Agenda are:**
  - Adequate shelter for all
  - The development of sustainable human settlements in an urbanizing world

SUSTAINABLE DEVELOPMENT GOALS REPORT

It is the only UN official report that monitors global progress on the 2030 Agenda for Sustainable Development. The report tracks the global and regional progress towards the 17 Goals, with in-depth analyses of selected indicators for each Goal. The report is published by Sustainable Development Solutions Network (SDSN).

Sustainable Development Goals Report 2022

Sustainable Development Report 2022 was titled "From Crisis to Sustainable Development: The SDGs as Roadmap to 2030 and Beyond". The key findings of the report include:

- The 2022 SDG Index is topped by three Nordic countries – Finland, Denmark and Sweden – and all top 10 countries are European countries.
- The average SDG Index score slightly declined in 2021.
- India ranked 121 out of the 163 countries compared to 117 in 2020 and 120 in 2021, slips in ranking for the third consecutive year.

Highlights from the Report

SDG 1: Between 657 and 676 million people are currently projected to live in extreme poverty in 2022, compared to the pre-pandemic projection of 581 million

SDG 2: About one in ten people are suffering from hunger worldwide, with 161 million additional people having slid into chronic hunger in 2020 alone

SDG 3: The COVID-19 pandemic is threatening decades of progress in global health, decreasing global life expectancy and basic immunization coverage and increasing prevalence of anxiety and depression and deaths from tuberculosis and malaria.

SDG 4: 147 million children have missed over half of in-person instruction in 2020-2021, and 24 million learners may never return to school.

SDG 5: Women accounted for 39% of total employment in 2019 but 45% of global employment losses in 2020, with many increasingly burdened with unpaid care work, and domestic violence intensifying.

SDG 6: Meeting drinking water, sanitation, and hygiene targets by 2030 requires a fourfold increase in the pace of progress.

SDG 7: Progress on electrification has slowed, with 679 million projected to have no electricity access in 2030, based on current trends;

SDG 8: One in ten children are engaged in child labour worldwide – a total of 160 million in 2020;

SDG 9: Global manufacturing has rebounded from the pandemic, but least developed countries (LDCs) are left behind.

SDG 10: The pandemic has caused the first rise in between-country income inequality in a generation.

SDG 11: Leaving no one behind will require an intensified focus on 1 billion slum dwellers;

SDG 12: 13.3% of the world's food is lost after harvesting and before reaching retail markets, and 17% of total food is wasted at the consumer level;

SDG 13: Energy-related carbon dioxide (CO2) emissions increased 6% in 2021 reaching their highest level ever.

SDG 14: In 2021, more than 17 million metric tons of plastic entered the ocean – a number projected to double or triple by 2040;

SDG 15: Ten million hectares of forest are destroyed every year, with almost 90% of global deforestation due to agricultural expansion;.

SDG 16: While the global homicide rate declined 5.2% between 2015-2020, a quarter of the global population lives in conflict-affected countries.

SDG 17: Net official direct assistance (ODA) reached a new high of USD 177.6 billion, largely due to COVID-19-related aid, but ODA for SDG data declined by more than 18% (2020).

Source: International Institute for Sustainable Development (IISD)

SDG INDIA INDEX

It is a tool developed by the NITI Aayog in collaboration with the United Nations to measure and track the progress of Indian states and union territories towards achieving the Sustainable Development Goals (SDGs). It was first launched in 2018.

SDG India Index 2020-21: It tracks progress of all States and UTs on 115 indicators that are aligned to MoSPI's National Indicator Framework (NIF).The 115 indicators incorporate16 out of 17 SDGs, with a qualitative assessment on Goal 17,andcover 70 SDG targets.

How are states classified and ranked

- **Scoring:** For each State/UT, a composite SDG Index score is calculated in the range of 0-100 based on its overall performance across 16 SDGs.

  The closer a State/UT is meeting the 2030 national targets, the higher its score.

- **Basis of Classification:** States/UTs are classified based on the SDG India Index Score as follows:
  - Aspirant: 0–49
  - Performer: 50–64
  - Front Runner: 65–99
  - Achiever: 100

Key Findings of the report

India's overall SDG score increased from 60 in 2019 to 66 in 2020–21, a gain of 6 points.

This is because facilities like access to clean energy and water, as well as sanitary facilities, have improved.

Category: As of now, there are no states in the aspirant and achiever category. Overall 15 states/UTs are in the performer category and 22 states/UTs in the front-runner category.

- Kerala has topped the index with a score of 75.
- It was followed by Himachal Pradesh and Tamil Nadu with a score of 74.
- Bihar, Jharkhand and Assam were the worst-performing states in the SDG India index.
- UTs: Chandigarh maintained its top spot among the UTs with a score of 79, followed by Delhi (68).
- **Top Gainers:** Mizoram, Haryana and Uttarakhand are the top gainers in 2020-21 in terms of improvement in score from 2019.

SDG Localisation

It is the process of transforming the SDGs into reality at the local level, in line with national frameworks and with communities' priorities. To be successful, localization needs to be anchored in the principles of inclusion, partnership and multilevel governance, and to build on adequate data and financing availability at the local level.

India and SDG Localisation

- With the introduction of TADP (Transformation of an Aspirational District Programme) in 2018, India started the "localisation" process.
- From the district level to the Gram Panchayat (GP) level, SDG localisation is used.
- Nine themes have been created to cover 17 SDGs as part of the Local Indicator Framework (LIF) at the GP level.

CHALLENGES IN ACHIEVING SDGS IN INDIA

India faces several challenges in achieving the Sustainable Development Goals (SDGs), including:

- **Poverty and inequality**: Despite progress in recent years, India still has a high poverty rate and significant income inequality. These factors can make it difficult to achieve several SDGs related to poverty reduction, health, education, and gender equality.
- **Environmental degradation:** India is one of the world's largest emitters of greenhouse gases and faces significant environmental challenges, including air pollution, water pollution, and deforestation. These challenges can make it difficult to achieve several SDGs related to environmental sustainability.
- **Infrastructure and access to services**: India has made significant strides in improving access to basic services like water and sanitation, but many people still lack access to these essential services. Additionally, there is a significant infrastructure deficit in many parts of the country, particularly in rural areas.
- **Governance and institutional capacity:** India faces significant challenges in governance and institutional capacity, including corruption, bureaucracy, and a weak rule of law. These challenges can make it difficult to implement policies and programs effectively, which is critical to achieving the SDGs.
- **Health and nutrition:** Despite progress in recent years, India still faces significant health and nutrition challenges, including high rates of malnutrition and maternal and child mortality. These challenges can make it difficult to achieve several SDGs related to health and well-being.

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GREEN ECONOMY

Green economy refers to an economic system that prioritizes sustainability and social and environmental well-being. It is an economy that aims to reduce environmental risks and ecological scarcities while promoting economic growth and development. In a green economy, natural resources are used efficiently and sustainably, and the production and consumption of goods and services are guided by principles of environmental sustainability.

For Example- This includes reducing waste and pollution, promoting renewable energy, and increasing energy and resource efficiency.

ORIGIN

The origins of the concept of a green economy can be traced back to the 1980s and 1990s when concerns about the environmental impacts of economic growth began to gain widespread attention. During this time, environmental economists and other experts began to explore ways in which economic development could be made more sustainable and environmentally friendly.

In 2011, the UNEP released a report titled "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication," which helped to popularize the concept of a green economy and provided a roadmap for its implementation.

OBJECTIVES OF GREEN ECONOMY

- Promote sustainable and inclusive economic growth and development
- Reduce environmental risks and ecological scarcities
- Increase energy and resource efficiency
- Promote renewable energy and sustainable production and consumption practices
- Reduce waste and pollution, and promote circular economy models
- Create new job opportunities in green sectors such as renewable energy, sustainable agriculture, and eco-tourism
- Address social inequalities and promote social inclusion, ensuring that the benefits of economic growth are shared equitably across all sections of society
- Improve human well-being and quality of life while minimizing negative environmental impacts
- Contribute to the achievement of global sustainable development goals, including those related to poverty reduction, climate change, and environmental sustainability.

INITIATIVES FOR GREEN ECONOMY

- **The United Nations Sustainable Development Goals (SDGs):** The SDGs provide a framework for global action on sustainable development, including the promotion of a green economy.
- **The Paris Agreement on climate change:** This agreement aims to limit global temperature rise and promote sustainable development by transitioning to a low-carbon, green economy.
- **The Circular Economy Action Plan:** This plan, developed by the European Union, sets out a comprehensive strategy for promoting a circular economy, reducing waste and pollution, and creating new jobs and economic opportunities.
- **Partnership for Action on Green Economy:** Launched in 2013, it is a global partnership that promotes the transition to a green and sustainable economy.
    - It is a collaborative effort between four United Nations agencies: the United Nations Environment Programme (UNEP), the International Labor Organization (ILO), the United Nations Industrial Development Organization (UNIDO), and the United Nations Development Programme (UNDP).
    - The main objective of the PAGE Initiative is to support countries in achieving sustainable development by promoting inclusive green economy policies and practices.

IMPORTANT CONCEPT ASSOCIATED WITH GREEN ECONOMY

Green Contracts

It is a legally binding agreement between the two contracting parties that incorporates environmentally friendly practices, products, or services into the terms and conditions. The goal is to encourage sustainable development, reduce environmental impacts, and promote the use of eco-friendly alternatives. Green contracts may cover a wide range of sectors, such as construction, transportation, energy, waste management, or procurement of goods and services.

Examples:

- A government agency issuing a contract for a construction project that includes requirements for using sustainable building materials, energy-efficient designs, or renewable energy systems.
- A company procuring office supplies and specifying that the products should be made from recycled materials or be eco-labeled.

Green Tenders

A green tender refers to a procurement process in which the organization or entity issuing the tender seeks proposals or bids that focus on environmentally sustainable solutions. The tender documents include specific requirements or criteria related to environmental performance, eco-design, energy efficiency, carbon footprint, waste reduction, or other sustainability indicators. By incorporating green criteria into tenders, the procuring entity aims to stimulate innovation, ensure resource efficiency and reduce waste management.

Examples:

- A municipality issuing a tender for waste management services, emphasizing the use of recycling and composting techniques to minimize landfill waste.
- An energy company inviting tenders for a renewable energy project, such as a solar power plant or wind farm, to increase the share of clean energy in the region.

Green Bonds

Green bonds are debt instruments issued by any sovereign entity, inter-governmental groups or alliances and corporates with the aim that the proceeds of the bonds are utilized for projects classified as environmentally sustainable.

Sovereign Green Bonds in India:

- The Government of India made an announcement to issue Sovereign Green Bonds during the Union Budget 2022-23 to honor its commitment to significantly reduce the carbon intensity of the economy.
- It aims to reduce Emissions Intensity of GDP by 45 per cent from the 2005 level by 2030, and achieve about 50 per cent cumulative electric power installed capacity generated from non-fossil fuel-based energy resources.
- Current source of finance: So far, India's climate actions have been largely financed from domestic resources and it is now targeting the generation of additional global financial resources from green bonds.
- Expected use of sovereign green bonds in India:
  - The government is expected to use proceeds from green bonds for projects such as renewable energy (solar, wind, biomass and hydropower energy), clean transportation, climate change adaptation, energy efficiency, sustainable water and waste management, pollution and prevention control and green buildings.

EXPECTED OUTCOMES OF A GREEN ECONOMY

Many experts have published various reports and studies indicating some positive expected outcomes of the green economy, including

- **Reduced environmental impact:** A green economy aims to reduce environmental degradation and minimize the carbon footprint of economic activities. This can be achieved through the adoption of clean technologies, renewable energy, and sustainable production and consumption practices.
- **Job creation:** As the green economy grows, it is expected to create new job opportunities in areas such as renewable energy, energy efficiency, and sustainable agriculture. This can also lead to the development of new industries and businesses.
- **Improved public health:** The shift towards a green economy can also improve public health outcomes by reducing air pollution, water pollution, and exposure to hazardous chemicals.
- **Enhanced resilience:** A green economy is designed to be more resilient to economic shocks and environmental disasters, as it emphasizes sustainable resource use and conservation.

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BLUE ECONOMY

The "Blue Economy" refers to the sustainable use and management of ocean resources for economic growth, improved livelihoods, and the preservation of ocean health. It emphasizes the importance of ocean ecosystems in providing food, energy, and other resources, while also recognizing the need to protect and restore these ecosystems.

ORIGIN

The concept of the Blue Economy has its origins in the work of Belgian economist Gunter Pauli, who first introduced the idea in his 2010 book, "The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs". He argued that the oceans could play a central role in this new model, given the vast array of resources and ecosystem services they provide.

Since then, the concept of the Blue Economy has gained increasing attention from policymakers, researchers, and business leaders as a way to promote sustainable development in coastal and marine areas. In 2012, the United Nations Conference on Sustainable Development (Rio+20) recognized the importance of the Blue Economy and called for its further development and implementation.

OBJECTIVES OF BLUE ECONOMY

- Promote sustainable economic growth and development in coastal and marine areas
- Conserve and sustainably use ocean resources for the benefit of present and future generations
- Create new jobs and business opportunities in sectors such as sustainable fisheries, aquaculture, renewable energy, and coastal tourism
- Increase food security by promoting sustainable fisheries and aquaculture practices
- Reduce poverty and promote social inclusion by supporting the development of small-scale fisheries and coastal communities
- Improve the health and resilience of ocean ecosystems through sustainable management and conservation measures
- Foster innovation and the development of new technologies and business models that support the sustainable use of ocean resources
- Strengthen international cooperation and governance frameworks for sustainable ocean management.

ACTIVITIES TARGETED UNDER BLUE ECONOMY AROUND THE WORLD

The following activities have been marked under Blue Economy and achieve sustainable development:

- **Sustainable fisheries:** Promoting sustainable fishing practices, such as using selective gear and reducing bycatch, to ensure the long-term health and productivity of fish stocks.
- **Aquaculture:** Cultivating fish, shellfish, and seaweed in a sustainable manner to provide food, income, and employment opportunities.
- **Marine renewable energy:** Developing renewable energy technologies such as wave, tidal, and offshore wind power to reduce dependence on fossil fuels.
- **Coastal tourism:** Supporting sustainable tourism activities, such as ecotourism, that generate economic benefits while minimizing negative impacts on the environment.
- **Marine biotechnology:** Developing new products and technologies based on marine organisms and ecosystems, such as medicines, cosmetics, and biodegradable materials.
- **Marine conservation:** Protecting and restoring marine ecosystems, such as coral reefs and mangroves, to ensure their ecological and economic value is preserved for future generations.
- **Ocean transportation and logistics:** Promoting efficient and sustainable transportation of goods and people through the development of low-carbon shipping and port infrastructure.

- **Coastal resilience:** Supporting the development of coastal communities and infrastructure that are resilient to the impacts of climate change, such as sea-level rise and increased storm surges.

INITIATIVES

At the Global Level:

- **United Nations' Sustainable Development Goal 14:** The UN's SDG 14 aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
- **The World Ocean Summit:** An annual event organized by The Economist Group that brings together business, government, and civil society leaders to discuss the challenges and opportunities of the Blue Economy.
- **The Blue Economy Challenge:** An initiative by the Nippon Foundation and the UNDP to support innovative solutions for sustainable ocean management.
- **Ocean 100:** A group of global companies committed to advancing sustainable ocean business practices and creating a more sustainable Blue Economy.

At National Level:

- **Sagarmala Project:** Launched in 2015 by the Ministry of Shipping, Government of India, to develop a port-led Blue Economy that focuses on sustainable coastal and maritime development.
- **National Policy for Marine Fisheries:** First introduced in 2017 and revised in 2021, by the Ministry of Fisheries, Animal Husbandry, and Dairying, a policy document that outlines the government's vision for sustainable development of marine fisheries in India.
- **Blue Revolution Scheme:** Launched in 2015 by the Ministry of Fisheries, Animal Husbandry, and Dairying, it aims to promote sustainable aquaculture and fisheries development in the country.
- **National Centre for Sustainable Coastal Management:** Established in 2013 by the Ministry of Environment, Forest, and Climate Change, an institution established to support the sustainable development of coastal and marine areas in India.
- **Pradhan Mantri Matsya Sampada Yojana (PMMSY):** A scheme launched by the Indian government in 2020 to promote sustainable and responsible development of fisheries and aquaculture in the country, with a focus on enhancing production, productivity, and quality of fish.
- **Fisheries and Aquaculture Infrastructure Development Fund (FIDF):** A fund established by the Indian government in 2018 to support the development of fisheries and aquaculture infrastructure in the country, including cold chain facilities, processing plants, and fishing harbors.
- **Matsya Setu Apps:** A suite of mobile applications launched by the Indian government to provide fisheries-related information and services to fish farmers, traders, and other stakeholders, including weather and market information, disease diagnosis, and technical advice.

CIRCULAR ECONOMY

According to the European Commission, "A circular economy is an economic system that aims to keep the value of products, materials, and resources in the economy for as long as possible and to minimize waste generation. It involves closing loops in product lifecycles through reuse, repair, remanufacturing, and recycling."

ORIGIN

The concept of a circular economy has its origins in ideas and approaches that emerged over time. It draws inspiration from industrial ecology, which examines the interconnectedness of industrial systems and natural ecosystems. The notion of "Cradle to Cradle" design, introduced by William McDonough and Michael Braungart, also influenced the development of the circular economy by emphasizing the continuous cycling of materials. The Ellen MacArthur Foundation, which was established in 2010, also popularised the concept through research and collaboration. The European Union's adoption of a Circular Economy Package in 2015 further propelled the concept into the mainstream. Today, the circular economy is gaining global recognition as a sustainable economic model that aims to minimize waste, promote resource efficiency, and create a regenerative system.

Core Principles:

There are three core principles of circular economy:

- **Design out waste and pollution:** This principle focuses on rethinking product design and production processes to minimize waste generation and environmental impact. It involves using sustainable materials, designing for durability, repairability, and recyclability, and considering the entire lifecycle of a product from its creation to its end-of-life.
- **Keep products and materials in use:** The aim here is to maximize the value and utility of products and materials by prolonging their lifespan. Strategies include promoting reuse, repair, refurbishment, and remanufacturing. By extending the life of products, the circular economy seeks to reduce the need for new resource extraction and minimize waste generation.
- **Regenerate natural systems:** This principle emphasizes the importance of preserving and restoring natural resources and ecosystems. It involves transitioning to renewable energy sources, adopting sustainable agricultural practices, protecting biodiversity, and closing resource loops through recycling, composting, and responsible waste management. The goal is to minimize environmental harm and enable the regeneration of natural systems.

Objectives:

The main objectives of the Circular Economy are:

- To maximize resource efficiency and minimize waste generation.
- Promote the reuse, repair, and recycling of materials to reduce environmental impact.
- To use renewable energy sources and decrease greenhouse gas emissions.
- To protect ecosystems and biodiversity by minimizing pollution and resource extraction.
- To stimulate economic growth and create job opportunities through innovation and new business models.
- To enhance economic resilience and security by diversifying supply chains and promoting local resource management.
- Support local employment and community development, taking into account the social dimensions of sustainability.

Six R's of Circular Economy:

The six "Rs" of the circular economy are a mnemonic device that helps to summarize the key actions and principles involved in transitioning towards a circular economy. The six Rs are:

- **Rethink:** This involves questioning and reevaluating current production and consumption patterns, as well as considering alternative approaches and business models that prioritize sustainability and resource efficiency.

Redesign: The focus here is on product and system redesign, aiming to create products that are durable, repairable, upgradable, and recyclable. Redesigning processes and systems can help minimize waste generation and maximize resource efficiency.

- **Reduce:** This refers to reducing the amount of materials, energy, and resources used in production and consumption. By minimizing unnecessary consumption and waste, it helps conserve resources and decrease environmental impact.
- **Reuse:** This involves extending the life of products and materials through reuse. By finding ways to use products multiple times, either in their original form or through repurposing, it reduces the need for new resource extraction and waste generation.
- **Repair:** Repairing products rather than replacing them promotes resource conservation and extends their lifespan. It encourages a shift away from a throwaway culture and encourages the development of repair services and infrastructure.
- **Recycle:** Recycling involves recovering materials from products at the end of their life and converting them into new products or materials. It helps reduce the demand for virgin resources and decreases the amount of waste that ends up in landfills.

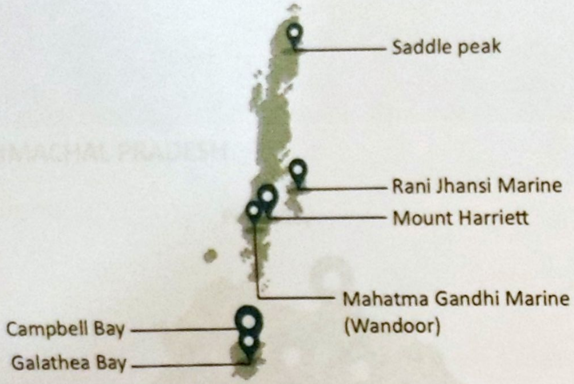
INITIATIVES TAKEN

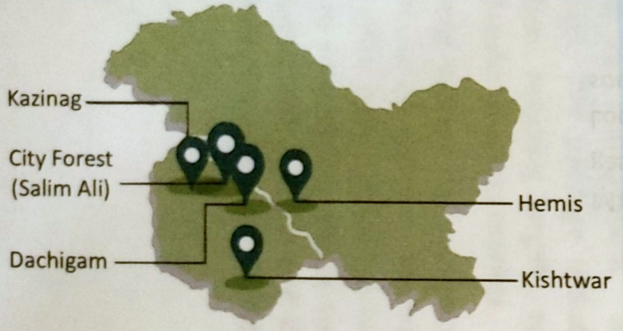
At the Global Level

- **European Union:** The European Union has been at the forefront of circular economy initiatives. In 2015, it adopted a comprehensive Circular Economy Package with targets and measures to enhance resource efficiency, waste management, and sustainable product design. The package includes actions on waste reduction, recycling targets, eco-design, and support for circular business models.
- **United Nations:** The United Nations has recognized the importance of the circular economy in achieving sustainable development goals. It has initiated various programs and platforms to promote circularity, such as the UN Alliance for Sustainable Fashion and the UN Industrial Development Organization's Circular Economy Network.
- **Global Partnership on Waste Management:** This initiative, led by the World Bank, aims to support countries in transitioning to a circular economy through waste management strategies. It focuses on reducing waste generation, improving recycling and waste treatment facilities, and promoting the circularity of materials.

At In dia Level

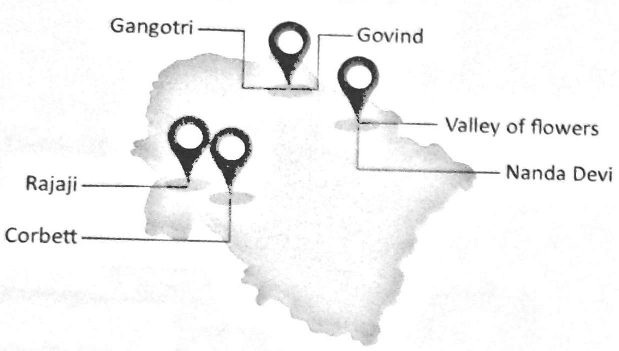
- **India's National Mission on Sustainable Habitat:** It was launched as part of the National Action Plan on Climate Change in 2008 by the Indian Government. It emphasizes sustainable urban development, waste management, and resource efficiency. It aims to promote circular practices in the building and construction sector and enhance resource conservation.
- **Make in India campaign:** It was launched by the Prime Minister of India in September 2014. It promotes the development of a manufacturing sector that embraces sustainability and resource efficiency. It encourages the adoption of circular economy principles by focusing on sustainable manufacturing practices, resource optimization, and waste reduction.
- **Swachh Bharat Abhiyan (Clean India Mission):** It was launched on October 2, 2014 by the Government of India. This national cleanliness campaign includes efforts to improve waste management systems and promote recycling and waste segregation practices. It aims to create a cleaner and more sustainable environment, fostering the transition to a circular economy.
- **Circular Economy Promotion and Financing Mechanism (CEFPM):** It was launched by the Government of India in November 2019. It seeks to mobilize funds for circular economy projects and provide support for research, technology development, and capacity-building activities related to circularity.

State	Name and Location	River System	Vegetation Type; Flora and Fauna
Andaman and Nicobar Islands  Saddle peak Rani Jhansi Marine Mount Harriett Mahatma Gandhi Marine (Wandoor) Campbell Bay Galathea Bay	Saddle Park Located in north Andaman	Kalpong River	Tropical evergreen & semi-evergreen forest. **Flora:** cratoxylum cochinchinense, diospyros marmota. Dipterocarp etc. **Fauna:** andaman wild pig, andaman hill myna, andaman imperial pigeon, water monitor, dolphins, whales, saltwater crocodile
	Mount harriet Located in Nicobar group of islands	---------	Tropical evergreen & Semi-Evergreen forest **Flora** Epiphytic vegetation, ferns, orchids **Fauna** Andaman wild pigs, Andaman wood, pigeon, saltwater crocodiles, turtles, robber crabs, butterfly hotspot
	Campbell bay Located in Nicobar group of islands	Galathea	Tropical evergreen & semi-evergreen forest **Flora** Orchids like bravura, trees like ferns, evergreen forests, mangrove forests, flowering plants **Fauna** Crab-eating macaque, white bellied sea eagle, megapode, crocodiles, deer, wild pig, bat
	Mahatma gandhi marine Located in south Andaman		Tropical evergreen & semi- evergreen forest, Mangrove forest **Flora** Orchids, bamboo, canes. Andaman bullet wood **Fauna** Angelfish, butterflyfish, white tip shark, white-bellied sea eagle, parakeets, pit vipers, krait, hawkbills
	Rani Jhansi marine Located in North Andaman		Mangrove forest **Flora** Coral Reefs, Mangrove Forest **Fauna** Dugong, Turtle, Crocodile, Bat

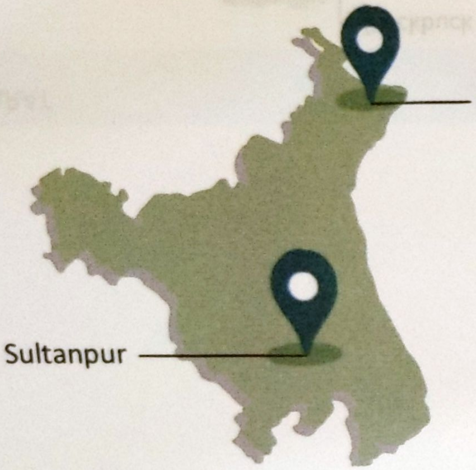
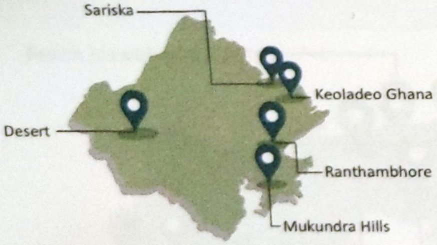
State	Name and Location	River System	Vegetation Type; Flora and Fauna
	Galathea Located in nicobar group of islands	Galathea River	Tropical evergreen & semi- evergreen forest **Flora** Angiosperms, Ferns, Gymnosperms, Bryophytes, Lichens **Fauna** Crab-eating macaques, Giant leatherback turtles, Nicobar tree shrews, Saltwater crocodiles, Monitor lizards, Palm civets, Malayan box turtles
Jammu&Kashmir and Ladakh  Kazinag City Forest (Salim Ali) Dachigam Hemis Kishtwar	Dachigam Srinagar district (east of dal lake) -zanskar range of northwest himalayas	Dagwan River	Coniferous Forest and mix vegetation **Flora** Wild Cherry, Pear, Plum, Peach, Apple, Apricot, Walnut, Chestnut, Oak, Willow, Poplar, Chinar, Birch, Pine, Elm **Fauna** Hangul Deer, Ibex, Musk deer, Brown Bear, Leopards, Jungle Cats, Himalayan black bear
	Hemis Lies in karakoram range, ladakh	Indus River (Bordered at North), Markha, Sumdah, Rumbak	Alpine & steppe forest **Flora** Pine forests, Junipers, Poplar, Myricaria, Salix, Astragalus, Birch, Taraxacum, Ephedra, Leortopodium **Fauna** Snow leopard, Himalayan marmot, Mountain weasel, Himalayan mouse Eurasian brown bear, Tibetan wolf
	Kishtwar	Rinnay river(North), Kibar Nala (South), Kiar, Nath	Alpine forest **Flora** Fir, Himalayan yew, Deodar, Blue pine, Kail, Spruce **Fauna** Snow leopard, Musk deer, Himalayan black bear, Himalayan brown bea
	Kazinag Lies in baramulla district of jammu & kashmir	North Bank of Jhelum River	Temperate system, with warm summers and cold winters **Flora** Deodar, Fir, Spruce, Kail **Fauna** Markhor Wild Goat, Himalayan Musk Deer, Himalayan Brown Bear, Himalayan marmot, Yellow-throated marten, Kashmir flying squirrel

State	Name and Location	River System	Vegetation Type; Flora and Fauna
	Salim ali Lies in srinagar in the city also known as city forest	Banks of Jhelum river	Estuarine Mangrove forest **Flora** Mangrove Forest **Fauna** Hangul, Himalayan Serow, Ring Dove, Bengal Florican, The Lesser Kestrel
HIMACHAL PRADESH Pin Valley Great himalayan Inderkilla Khirganga Col. Sherjung Simbalbara	Great himalayan Banjaar sub-division of kullu district	Jiwa, Sainj, Tirthan rivers	Moist deodar forest, Western mixed coniferous forest, Moist temperate deciduous forest, Himalayan alpine pastures, Rhododendron scrub forest **Flora** Oak, Blue pine, Cedar, Deodar, Bamboo, Arundaria, Spathiflora-iris **Fauna** Blue sheep, Snow leapoard, Common leopard, Himalayan brown bear, Himalayan tahr, Musk deer, Serow
	Pin valley Lies in spiti valley in the lahaul and spiti district	Pin river, Paraiho River	Alpine pasture or dry alpine Scrub Forest **Flora** Juniper, Birch, Salix, Myricaria, Bhutal **Fauna** Siberian Ibex, Snow Leapoard, Baral, Woolly hare, Tibetan gazzle, Snow Cock
	Inderkilla Lies in kullu district	Beas river	Coniferous forest with mixed deciduous trees **Flora** Eucalyptus, Acacia, Jamun, Shisham, Mango, Mulberry, Ficus **Fauna** Brown and black bears, Leopards, Deer
	Khirganga Lies in kullu	Parvati River	Temperate forest **Flora** Sal, Maple, Chestnut **Fauna** Snow leopard, Blue sheep, Himalayan brown bear, Himalayan tahr
	Simbalbara Paonta valley of sirmour district	Parvati River	Temperate forest **Flora** Sal forest, Medicinal plants **Fauna** Tiger goral, Sambhar, Chittal, Goral, Spotted deer, Himalayan black bear,

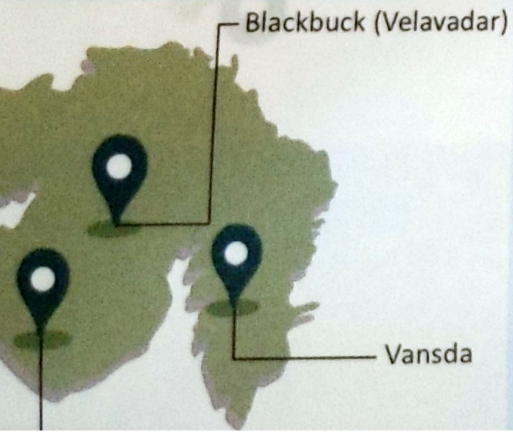
UTTARAKHAND



Jim corbett Nainital district	Ram Ganga, Khoh, Kholu, Mandal	Dense Moist deciduous Forest **Flora** Teak, Silver Oak, Eucalyptus, Jacaranda, Bottlebrush **Fauna** Langurs, Sloth bears, Asiatic black bears, Indian grey, Mongooses, Wild boars, Barking deer
Rajaji Nestled between the shivalik ranges and the indo-gangetic plains	Ganga, Song	Tropical moist and dry deciduous forest **Flora** Broadleaved, Deciduous forests, Riverine vegetation, Scrubland, Grasslands, Pine forests **Fauna** Royal Bengal Tiger, Jackal, Hyena, Jungle Cat, Leopard Cat, Civets
Valley of flower Located in chamoli district	Pushpawati River	Sub-alpine forest **Flora** Orchids, Poppies, Primilas, Marigold, Daisies, Geranium, Petunia, Sediams **Fauna** Asiatic black bear, Snow leopard, Brown bear, Blue sheep
Nanda devi Chamoli garhwal district, between the rishiganga valley on the west and the goriganga valley on the east	Alaknanda, Rishi Ganga, Dhauli Ganga, Pushwapati, Khiro Ganga	Alpine forest **Flora** Fir, Birch, Rhododendron, Junip **Fauna** Snow leopard, Himalayan black bear, Brown bear, Musk deer, Bharal/ blue sheep
Gangotri Located in the upper catchment of bhagirathi river in the uttarkashi district	Bhagirathi	Subalpine conifer forests at lower elevations -Alpine shrub and meadows at higher elevations **Flora** Chirpine deodar fir, Spruce, Oak, Rhododendrons **Fauna** Blue sheep, Black bear, Brown bear, Himalayan Monal, Himalayan snowcock, Himalayan thar, Musk deer, Snow leopard

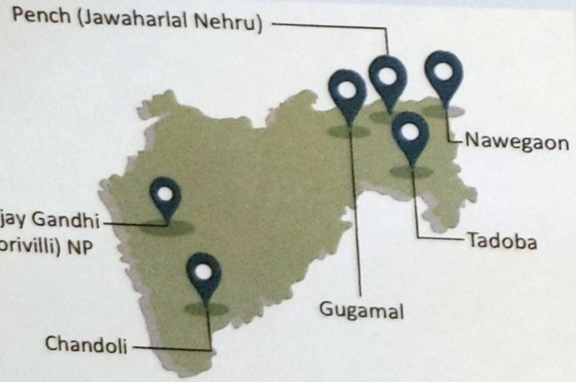
State	Name and Location	River System	Vegetation Type; Flora and Fauna
	Govind pashu vihar Located in supin range, near uttarkashi town of uttarkashi district	Tones River	Alpine,sub-alphine forest -Broadleaf Forest **Flora** Blue pine, Silver fir, Spruce, Yew, Deciduous species **Fauna** Asian black bear, Brown bear, Common leopard, Musk deer, Bharal, Himalayan tahr, Serow
ARYANA  	Sultanpur Located in sultanpur village, farukhnagar, gurugram district	Yamuna River	Tropical and dry deciduous **Flora** Dhok, Khair, Tendu, Ber, Jamun, Acacia **Fauna** Striped hyenas, Blue bull, Wild dog, Wild cat, Four horned antelope, Indian porcupine, Hedgehog
	Kalesar Located in yamunanagar district of haryana		Tropical and dry deciduous **Flora** Sal tree, Semul, Amaltas **Fauna** Rusty, Spotted cat, Jungle cat, Asiatic elephant
RAJASTHAN  Sariska Keoladeo Ghana Desert Ranthambhore Mukundra Hills	Keoladeo ghana It is located in bharatpur which also consist of bird sanctuary	Gambhir River, Banganga	Tropical dry deciduous forests intermixed with dry grasslands **Flora** Kadam, Jamun, Babul, Ber **Fauna** Siberian Crane, Nilgai, Chital, Sambar, Indian Porcupine, Indian Gray Mangoose, Jungle Cat, Fishing Cat, Civet, Jackals, Striped hyenas
	Ranthambore Located in -located in sawai madhopur	Banas River to north, Chambal River to south	Tropical dry deciduous forest **Flora** Dhok, Tamarind, Mango, Banayan, Babul **Fauna** Bengal tiger, Indian leopard, Caracal, Jungle cat, Rusty, Spotted cat, Indian elephant, Wild water buffalo, Gaur, Nilgai, Barasingha, Blackbuck, Chinkara, Chousingha

Sariska Situated in the alwar district	Ruparel River	Tropical dry deciduous forest -tropical dry thorn forest **Flora** Dhok tree, Salar, Kadaya, Dhak, Gol, Ber, Khair, Bargad, Arjun, Gugal, Bamboo **Fauna** Bengal tiger, Indian leopard, Jungle cat, Caracal, Sambar, Striped hyena, Golden jackal, Chital, Four horned antelope
Mukundra -located and based between the mountains of mukundra and gagrola	Ramzan Kali, Ahu, Chambal	Tropical dry deciduous forest **Flora** Dhok trees and a mixed jungle, sheesham , belimali, arjun, ficus, khair, Gurjan **Fauna** Bengal tiger, Indian wolf, Indian leopard, Sambar, Mugger crocodile, Gharial Chinkara
Desert It is spread in two district that is balmer and jaisalmer	Luni River	Tropical dry thorn forest **Flora** open grassland, Thorny bushes, dunes **Fauna** Toad-headed agama, Sindh awl-headed snake, Indian spiny, Tailed lizard, dwarf gecko, persian gecko, desert monitor, saw-scaled viper
Gir It is located in north-east of somnath, south-east of junagadh and south-west of amreli	Hiran, Shetrunji, Dhatarvadi, Shingoda, Machhundri, Ambajal, Raval	Tropical dry deciduous forest **Flora** Jambu, karanj ,umro, vad , kalam, Charal, Siris, Amli **Fauna** Chital, Nilgai, Sambar, Four-horned -antelope, Chinkara, Wild boar



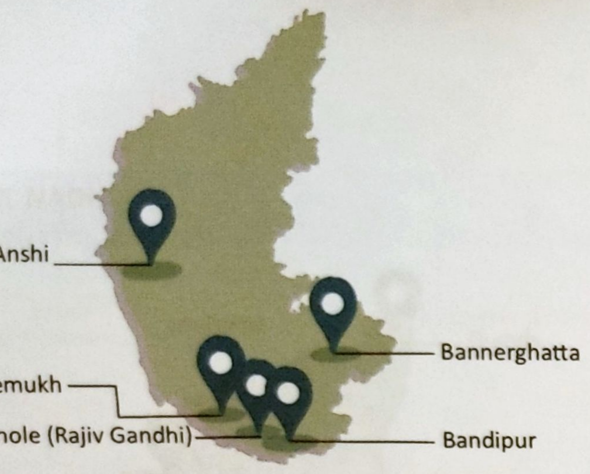
Name and Location	River System	Vegetation Type; Flora and Fauna
Velavadar Located at velavadar in the bhavnagar district	Parvalia, Alang	Tropical dry deciduous forest **Flora** Kalam, Sirus, Charal, Acacia, Jambu, Amli, Karanj -banyan **Fauna** Blackbuck, bluebull, wolf, jackal, jungle cat, fox, lesser florican
Vansda Located in the vansda taluka of valsad district of south gujarat.	Ambika River	Tropical moist deciduous forest **Flora** Teak, sadad, khakhro, kadad, numb, timru, kalam Dudhkod, mahudo **Fauna** Leopard, hyena, jungle cat ,civets, mongooses, macaques, barking deer, four-horned antelopes, spotted deer
Marine (gulf of kachchh) It is situated on the southern shore of the gulf of kutch in the devbhumi dwarka district	Gulf of Kutch	Tropical forest **Flora** Colourful sponges and corals - **Fauna** Sea anemones, Jelly fishes, sea horse, octopus, Pearl oyster, sabela, Dugong, Shark

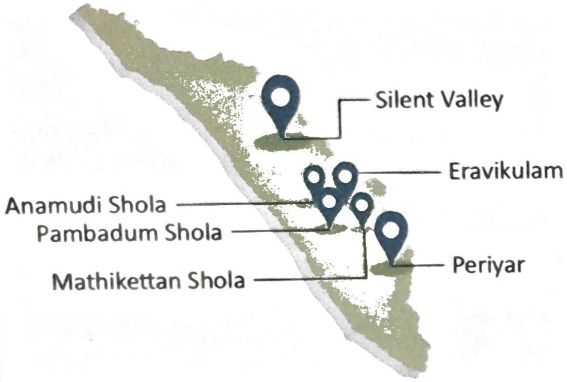
ARASHTRA

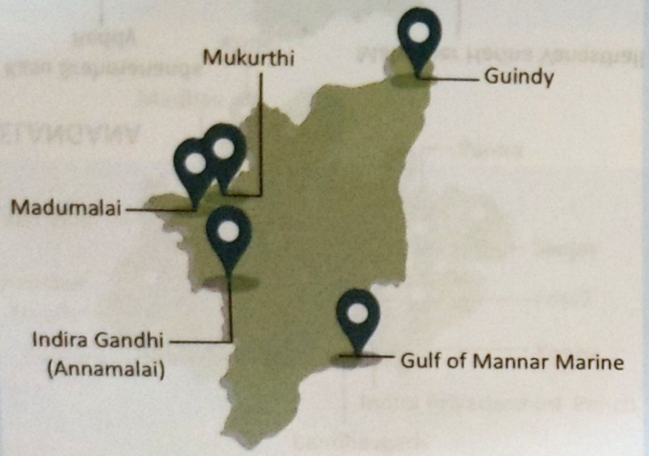


Name and Location	River System	Vegetation Type; Flora and Fauna
Tadoba Located in chandrapur district, which includes tadoba-andhari tiger reserve and andhari wildlife sanctuary	Andhari River	Tropical dry thorn forest **Flora** Bija, teak, dhauda, hald, salai. semal, tendu **Fauna** Royal bengal tiger, Leopard, cheetal, Chinkara, Langoors, nilgai, barking dear, blue bull
Candoli Located near the chandoli dam, spread over satara, kolhapur and sangli	Warna River	Tropical moist deciduous forest **Flora** Anjani ironwood tree, Jamun, Pisa, Fig, olea, katak spinous kino tree, nana or crape, myrtle, kinjal **Fauna** Tiger, leopard, Indian bison, Leopard cat, Sloth bear, Giant squirrel

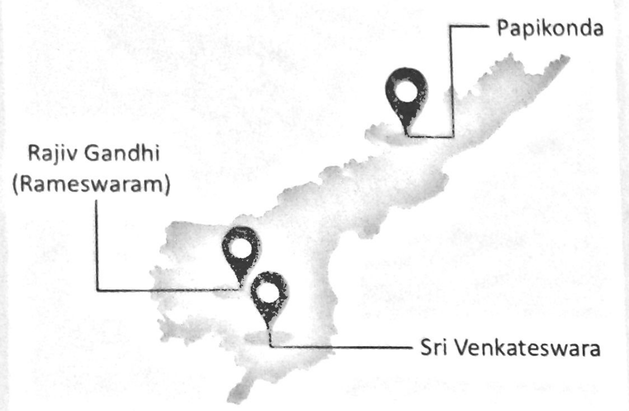
Name and Location	River System	Vegetation Type, Flora and Fauna
Gugamal Located in the chikhaldara and dharni tehsils of amravati	Gadga River, Dolar River	Tropical Dry deciduous forest **Flora** Teak, Ain, Indian gooseberry, Lendia, Dhawad, Kusum trees **Fauna** Bengal tiger, Indian leopard, Sloth bear, Ussuri dhole, Indian jackal,Striped hyena, Four-horned antelope, Sambar, Barking deer, Honey badger, Cheetal, Nilgai
Sanjay gandhi Situated partly in thane district and in mumbai suburban district	Dahisar River	Tropical Mixed-Deciduous forest **Flora** Kadamba, Teak, Karanj, Shisham, Red silk cotton tree, Other varieties of flowers **Fauna** Black-naped, Barking deer, Porcupine, Asian palm civet, Mouse deer, Grey langur, Indian flying fox, Sambar deer, Leopard
Nawegaon *Located in the arjuni morgaon subdivision of gondia district*	Gadvi River	Tropical Dry deciduous forest **Flora** Teak, Jamun, Mahua, Bhor, Bhel, Ain, Haldu, Kawat **Fauna** Tiger, Panther, Jungle cat, Small India Civet, Palm Cavet, Wolf, Jackle
Pench *Located in the districts of seoni and chhindwara*	Pench River	Tropical Dry deciduous forest **Flora** Moyan, mahua, mokha, skiras, tendu, bija, achar, garari, aonla **Fauna** Indian leopard -sloth bear, indian wolf, indian wild dog, Wild boar, Chital, Jackal, Hyena, Wolf

te	Name and Location	River System	Vegetation Type; Flora and Fauna
NATAKA  Anshi Bannerghatta emukh hole (Rajiv Gandhi) Bandipur	Bannerghatta It is situated almost midway between the city centre of bengaluru and the anekal town	Suvarnamukhi Stream	Dry deciduous and Tropical Moist **Flora** Jack fruit, Neem, Red silk cotton, alada mara **Fauna** Elephant, Leopard, Bison, Chital, Sambar, Sloth Bear, Barking Deer, Wild Boar, Wild Dog, Jackal, Mouse Deer, Bonnet Macaque, Striped Hyena, Porcupine
	Bandipur Located partly in gundlupet taluk of chamarajanagar district and partly in h.d.kote and nanjangud taluks of mysuru district	Nugu River, Kabini River, Moyar River	Dry deciduous and Tropical Moist **Flora** Teak, Sandalwood, Rosewood, Indian kino tree, Indian laurel, Clumping bamboo **Fauna** Asian elephant, Gaur, Bengal tiger, Sloth bear, Four-horned antelope, Golden jackal, Dhole
	Nagarhole Located in kodagu district and mysore district	Nagarhole River, Kabini River	Moist, tropical and mixed deciduous forest **Flora** Teak, sandalwood, rosewood, crocodile bark, axle wood **Fauna** Bengal tiger, leopard, Asiatic Elephant, Reptiles, Guars, Deer, Antelopes, Wild dogs, Bears
	Kudremukh Located at the tri-junction of dakshina kannada, udupi district and, chikamagaluru distric	Tunga, Bhadra, Nethravathi	Tropical evergreen -Tropical Semi-evergreen **Flora** Nilambur, Cobra lily, Jewel orchid, Acacia, Silk oaks **Fauna** Tiger, Panther, Wild dog, Bison, Elephant -Sambar, Spotted deer, Sloth bear, Wild boar, Lion tailed Macaque, Common langur, Bonnet macaque
	Anshi It is located in uttara kannada district	Kali River	Tropical evergreen Rainforest **Flora** Teak, Oak, Bamboo, Eucalyptus, Lantana, Jamba ,Tamarind, Bintangur **Fauna** Black panthers, Tiger, Elephants, Sloth bear, Bonnet macaque, Slender grey loris, Barking deer, Indian wild boar, Mouse deer, Indian bison

State	Name and Location	River System	Vegetation Type; Flora and Fauna
KERALA  Silent Valley Eravikulam Anamudi Shola Pambadum Shola Periyar Mathikettan Shola	Anamudi shola Located along the western ghats of idukki district	Chinnar, Pambar	Montane wet temperate forests and moist deciduous forests **Flora** Tree, herbs & shrubs, climbers, Mannavan shola, Idivara shola, Pullardi shola **Fauna** Spotted deer, Giant grizzled squirrel, Sambar, Gaur, Sloth Bear, Hanuman Langur, Leopards, Wolves
	Eravikulam Located along the western ghats in the idukki and ernakulam districts	Chinnar, Pambar	Temperate & tropical grassland **Flora** Grassland, Shrubland, Forest **Fauna** Nilgiri tahr, Gaur, sloth bear, Nilgiri langur,tiger,leopard, giant squirrel, wild dog
	Periyar It is located high in the cardamom hills and pandalam hills of the south western ghats along the border with tamil nadu	Periyar River	Tropical evergreen, semi -evergreen and moist deciduous forests -Grasslands **Flora** Teak, Rosewood, Terminalia, Sandalwood, Tamarind **Fauna** Sambar, Gaur, Mouse Deer, Barking Deer, Indian Wild Dog, Tiger
	Silent valley It is located in nilgiri hills	Kunthi River	Tropical evergreen, sub-tropical broad leafed forest, montane forest **Flora** Teak,Rosewood, Amla, Bamboo, Bemal **Fauna** Indian nightjar, Tiger, Leopard, Leopard cat, Jungle cat, Common palm civet, Small indian civet, brown palm civet, ruddy mongoose, stripe-necked mongoose -dhole, clawless otter, small travancore, flying squirrel
	Mathikettan shola Located in poopara village of udumbanchola taluk in idukki district	Chethipuzha Streams, Mathikettanpuzha Streams, Njandar Streams	Tropical evergreen forests, moist deciduous forests, shola grasslands and semi-evergreen **Flora** Traditional medicines plants, Cardamom, Bhesa indica **Fauna** Gaur, Wild boar, Sambar, Common langur, Wild dog, Jungle cat

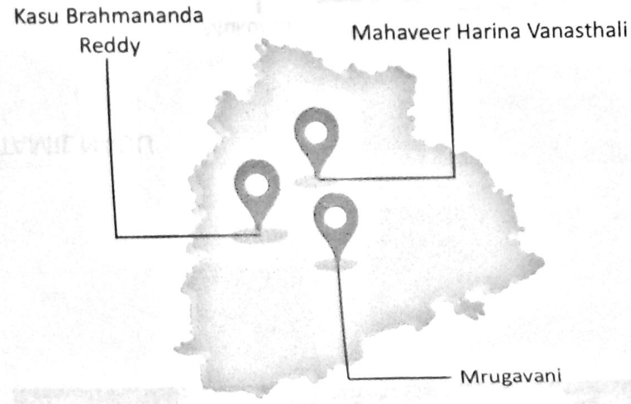
State	Name and Location	River System	Vegetation Type; Flora and Fauna
	Pambadum shola It is the smallest national park in idukki district		Shola forest **Flora** Shola forest, Grassland, Transition forest, Shrubland **Fauna** Elephant, Gaur, Leopard, Wild boar, Sambar, Common langur
TAMIL NADU  Mukurthi Guindy Madumalai Indira Gandhi (Annamalai) Gulf of Mannar Marine	Mukurthi Lies at the southwestern end of the nilgiri hills	Billithadahalla, Pykara, Kundah	Montane wet temperate mixed forests (Shola), Grasslands **Flora** Eucalyptus, Cypress, Indian long leaf pine, Thorny gorse **Fauna** Leopard, bonnet, macaque, Sambar deer, Barking deer, Mouse deer, Otter, Small Indian civet, Black-naped, Malabar spiny dormouse
	Guindy It lies in the heart of the city	Adyar River	Dry evergreen scrub and thorn forests **Flora** Sugar-apple, Atlantia monophylla **Fauna** Blackbuck, Spotted deer,Jackal , Small Indian civet, Common palm civet, Bonnet macaque, Hyena, Pangolin, Hedgehog, Common mongoose, Three-striped palm squirrel
	Indira gandhi (annamalai) It is spread over in tiruppur district	Moyar River	Evergreen & Semi evergreen Forest **Flora** Teak, Rosewood, Tropical species **Fauna** Elephant, Gaur, Tiger, Panther, Sloth bear, Deer, Wild bear, Wild dog, Porcupine, Flying squirrel, Jackal, Pangolin. Civet Cat
	Gulf of mannar marine It lies 1 to 10 km away from the east coast of tamil nadu	Thamirabarani River, Vaippar River, Malvathu River	Mangrove forest **Flora** Coral reefs, Seaweed communities, Sea grasses, Mangroves **Fauna** Five species of turtles, dolphins, whales, sea cucumber, dugongs
	Mudumalai It is situated in the nilgiri mountains	Moyar River	Tropical and subtropical moist broadleaf forests **Flora** - Teak, Axlewood, Sandalwood, Mango, Tamarind, Pipal **Fauna** - Deer, Gaur, Indian elephant, Bengal tiger, Striped hyena, Golden jackal, Bonnet macaque, Leopard cat

ANDHRA PRADESH

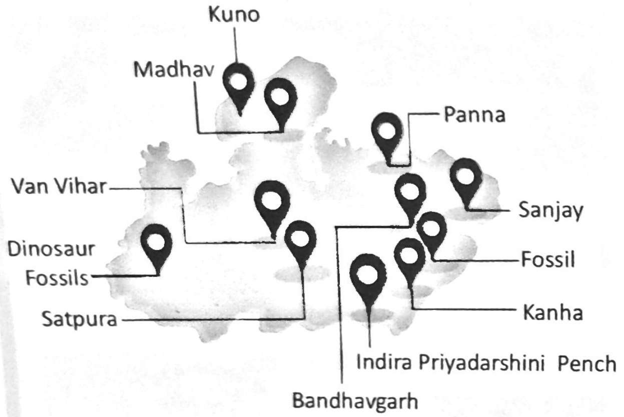


Papikonda Located near rajamahendravaram in the papi hills of the alluri sitharama raju and eluru districts	Godavari	Moist deciduous and dry deciduous forests **Flora** Pterocarpus, Marsupium, Terminalia elliptical, Terminalia arjuna, Adina cordifolia, Sterculia urens **Fauna** Tiger, Leopard, Hyena, Indian gaur, Sambar, Barking Deer, Chowsinga
Rajiv gandhi Situated in the central plains of extensions hill ranges of veligondas, palakondas, lankamallais and yerramalais in the cuddapah district	Penna River	Tropical Dry Deciduous forests **Flora** Dalbergia sissoo, Grewia villosa, Gymnema , Sylvestre **Fauna** Tigers, Leopard, Wild dog, Sambar, Barking deer, Sloth bear, Wild boar, Bison, Langur, Mouse deer, Slender loris, Jackal, Porcupine
Sri venkateswara Located in southern eastern ghats, are spread over the seshachalam hills of cuddapah district and tirumala hills of chittoor district	Kalyani River	Tropical Dry Deciduous and mixed deciduous forests **Flora** Shorea robusta, santalum album, red sanders, sterculia urens, east indian cork, screw tree **Fauna** Leopard, slender loris, sloth bear, mouse deer, Giant squirrels, Four horned antelope

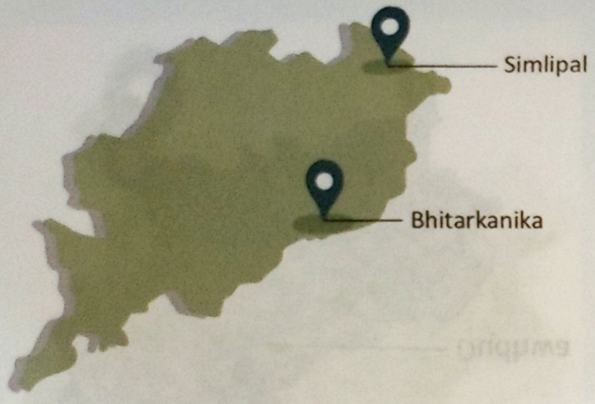
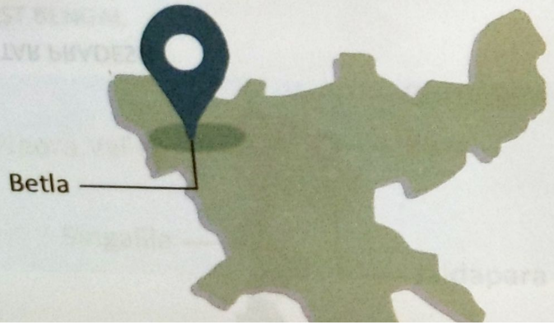
TELANGANA

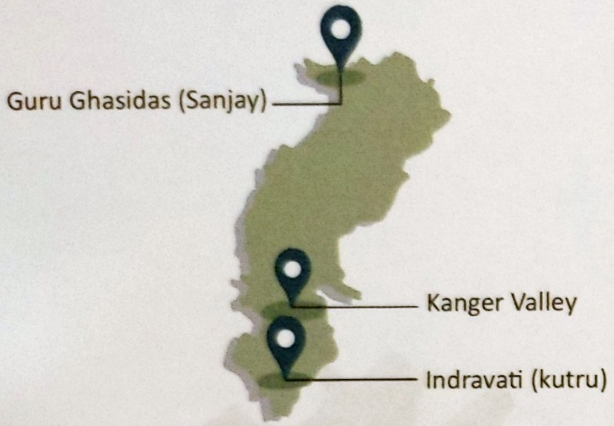


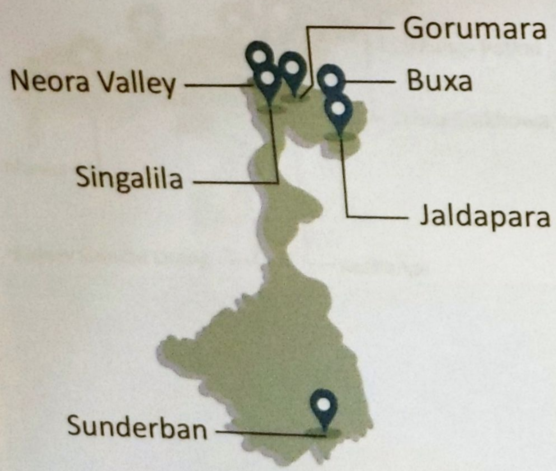
Mrugavani Located at chilkur in moinabad mandal		Tropical Dry Deciduous forests **Flora** Teak, Bamboo, Sandal, Picus, Palas, Rela **Fauna** Cheetal, sambar, Wild boar, Jungle cat, Civet cat, Mongoose monitor, Lizard, Python, Russell Viper
Kasu brahmananda reddy It is located in jubilee hills/banjara hills		Tropical Dry Deciduous forests **Flora** Sandalwood, Teak, Neem **Fauna** Hares, Porcupines, Civet cat, Jungle cat, Jackal, Pangolin

State	Name and Location	River System	Vegetation Type; Flora and Fauna
	Mahaveer harina vanasthali Located in vanasthalipuram saheb nagar, hyderbad		Tropical Dry Deciduous forests **Flora** Sandalwood, Rosewood, Acacias **Fauna** Fan throated lizard, Orange blister beetle, White naped woodpecker
MADHYA PRADESH 	Kanha Situated in the two districts mandla and balaghat	Halon, Banzar	Tropical moist deciduous forest, dry deciduous forest **Flora** Sal, Saja, Lendia, Dhawa. Tendu, Palas, Bija, Mahua, Aonla, Achar **Fauna** Bengal tiger, Indian leopard, Dhole, Sloth bear, Panther, Chital, Sambar, Barasingha, Black buck, Barking deer, Bengal fox, Indian jackal
	Bandhavgarh It is located in district umaria	Chiranganga River	Tropical moist deciduous forest, dry deciduous forest -grassland **Flora** Sal, Saja, Dahuda, Tendu, Arjun, Palas, Salai **Fauna** Tiger, Leopard, Sambar, Chital, Barking deer, Sloth bear, Common langur, Barasingha
	Pench It is located on the southern boundary of madhya pradesh, bordering maharashtra, in the districts of seoni and chhindwara	Pench River	Tropical Dry Deciduous forests **Flora** Moyan, Mahua, Mokha, Skiras, Tendu, Bija, Garari, Aonla, Ghont, Baranga, Aonla **Fauna** Chital, Sambar, Nilgai, Wild boar, Jackal, Indian leopard, Sloth bear, Indian wolf, Porcupine, Jungle cat, Fox, Striped hyena, Gaur, Four-horned antelope, Barking deer
	Panna It is located in panna and chhatarpur districts	Ken River	Tropical dry deciduous forest **Flora** Thorny woodlands, Shrubs, Tendu, Achar, Seja, Mahua, Saja, Salai, Bel **Fauna** Bengal tiger, Indian leopard, Chital, Chinkara, Nilgai, Sambar deer, Sloth bear, Rusty-spotted cat, civet

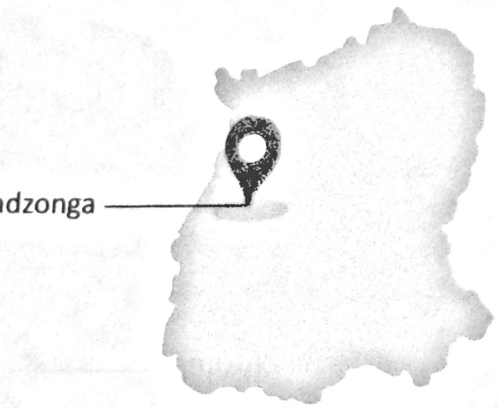
Name and Location	River System	Vegetation Type; Flora and Fauna
Satpura It is located in the narmadapuram district	Denwa River	Tropical dry deciduous forest **Flora-** Sal, Teak, Tendu, Phyllanthus emblica, Mahua, Bel, Medicinal plants **Fauna-** Leopard, Sambar, Chital, Indian muntjac, Nilgai, Four-horned antelope, Chinkara, Wild boar, Bear, Black buck, Fox, Porcupine, Flying squirrel, Mouse deer, Indian giant squirrel
Kuno It is situated almost in the centre of kuno wildlife division of sheopur district and it is a part of the central indian vindhyan hills	Kuno River	Tropical Dry deciduous forest **Flora-** Kardhai, Salai, Khair trees **Fauna-** Indian leopard, Southeast African cheetah, Jungle cat, Sloth bear, Dhole, Indian wolf, Indian jackal, Striped hyena, Bengal fox
Madhav Situated near shivpuri town and is a part of the upper vindhyan hills	Sinndh River	Tropical dry deciduous mixed forest -Thorn Forest **Flora-** Dhawda, Palash, Khair, Kardhai, Salai **Fauna-** Nilgai, Chinkara, Chowsinga, Deers, Chital, Sambar, Barking Deer
Van vihar It is located in Bhopal district		Tropical dry deciduous mixed forest, Grasslands **Flora-** Teak, Kardhai, Salai, Palas, Tendu , Gurajan, Grasses types, Rusa, Dub, Kush, Kusai, Chhir, Kanas **Fauna-** Cheetal, Blackbuck, Tiger, Lion, Panther, Bear, Hyena
Mandla plant fossil It is situated in Dindori district	Narmada, Tapti	Tropical dry deciduous mixed forest **Flora -** Palm, Neem, Jamun, Banana, Rudraksh, Jackfruit, Aonla
Dinosaur Fossils It is situated in Dhar District		Tropical dry deciduous forest. **Flora-** The floral Fossils include Gymnosperm, Araucaria, Podocarpus, Jack fruit, Palm tree species and Blue Green algae. **Fauna-** The Faunal Fossils include Dinosaur Bones, Eggs, Scat, Echinodermata, Mollusca, fish and Porifera Species.
Sanjay national park Located in manendragarh-chirmiri- bharatpur		Tropical dry deciduous forest **Flora-** Sal trees **Fauna-** Red-headed vulture, White rumped vulture, Egyptian vulture

State	Name and Location	River System	Vegetation Type; Flora and Fauna
ORISSA 	Bhitarkanika Situated in the north-eastern part of kendrapara district	Brahmani, Baitarani, Dharma, Pathsala	Mangrove forest **Flora** Mangrove species, Casuarinas, Grasses like the indigo bush **Fauna** Black ibis, Wild boar, Rhesus monkey, Chital, Darter, Cobra, Monitor lizard
	Simlipal It is a tiger reserve in the mayurbhanj district	Budhabalang, Baitarani, Subarnarekha	Moist deciduous forests Flora Cotton Tree, Mahua, Orchid Species **Fauna** Bison, Sambhar, Chital, Porcupine, Pangolin, Pythons, Leopard, Barking Deer, Giant Squirrel
JHARKHAND 	Betla Located on the chota nagpur plateau in the latehar and palamu district	North Koel River	Tropical wet evergreen forests, mixed deciduous forests and temperate alpine forests **Flora** Sal, Bamboo, Medicinal Plants **Fauna** Elephant, Panther, Leopard, Wild Boar, Tiger, Gaur, Sloth Bear, Sambar, Chital, Mouse Deer

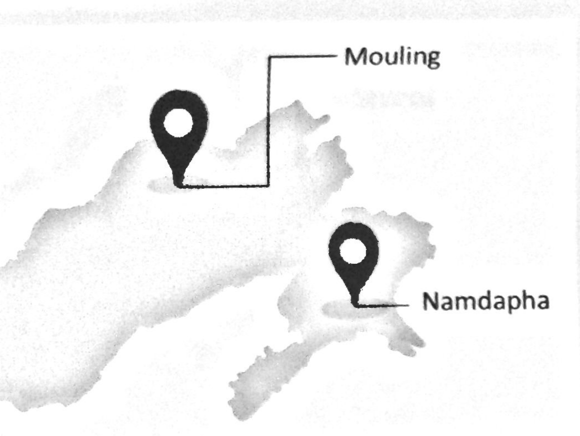
State	Name and Location	River System	Vegetation Type; Flora and Fauna
CHATTISGARH  Guru Ghasidas (Sanjay) Kanger Valley Indravati (kutru)	Guru ghasidas It is located in the koriya district	Banas River	Tropical dry deciduous mixed forest **Flora** Sal, Teak, Saja, Salai, Mahua, Sisham, Kari, Gurjan, Achar, Tendu **Fauna** Tigers, Leopards, Nilgai, Jackal, Antelope, Wild boar, Bison, Hyena, Porcupine
	Kanger gati It is located near jagdalpur in the bastar region	Kanger River	Mixed humid deciduous type **Flora** Sal, Saugaun teak, Bamboo trees **Fauna** Bastar myna, Tigers, Leopards, Mouse deer, Chital, Sambar, Barking deer, Jackals, Langurs, Rhesus macaque
	Indravati It is located in bijapur district	Indravati River	Tropical Moist and Dry Deciduous **Flora** Sal, Teak, Bamboo **Fauna** Wild water buffalos, Chital, Chausingha, Barking deer, Nilgai, Gaurs
UTTAR PRADESH 	Dudhwa It is part of the dudhwa tiger reserve in the kheri and lakhimpur districts	Mohana River	Tropical moist deciduous forest -tropical semi-evergreen forest -dry deciduous forest -swamp forest **Flora** Sal, Asna, Shisham, Jamun, Gular, Sehore, Bahera **Fauna** Tiger, Rhinoceros, Swamp deer -elephant, Sambar, Hog deer, Cheetal, Kakar, Rhesus monkey, Langur, Sloth bear, Blue bull, Porcupine

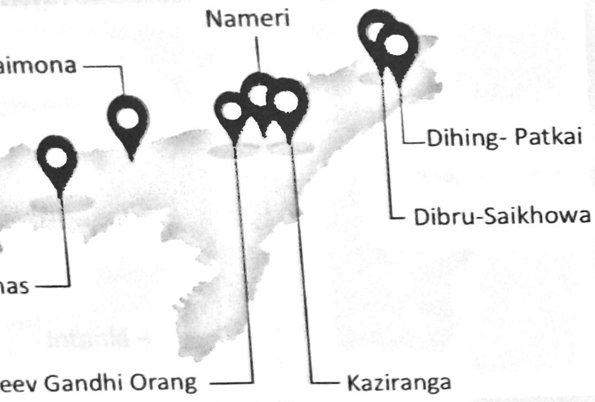
State	Name and Location	River System	Vegetation Type; Flora and Fauna
BIHAR 	Valmiki It is a tiger reserve in the west champaran district	Gandak, Manor, Pandai, Harha, Masan, Bhapsa	Moist mixed deciduous **Flora** Sal, Piyar, Mandar, Banjan, Bhelwa, -Harra, Bodera **Fauna** Tiger, Sloth Bear, Leopard, Wild dog, Bison, Wild boar Krait, Monitor Lizard
WEST BENGAL  Gorumara Neora Valley Buxa Singalila Jaldapara Sunderban	Jaldapara Foothills of the eastern himalayas in alipurduar district	Torsha River	Vast grassland **Flora** Villosa, Setaria, Palmifolia **Fauna** One horned rhinoceros, Sambar, Hog deer, Barking deer
	Singalila Located on the singalila ridge	Rammam River, Srikhola River	Temperate and alpine forest **Flora** Primulas, Aconites, Asters, Arisaema, Meconopsis **Fauna** Red panda, Leopard cat, Barking deer, Yellow-throated marten, Pangolin
	Sunderban Located in 24 parganas district	Ganges, Brahmaputra, Meghna	Mangrove forest **Flora** Sundari, Gewa, Goran, Keora **Fauna** Tiger, Fishing cat, Leopard cat, Jungle cat, Rhesus macaque, Wild boar, Indian, Grey mongoose, Smooth-coated otter, Spotted deer

Name and Location	River System	Vegetation Type; Flora and Fauna
Neora valley Situated in the kalimpong subdivision under darjeeling district	Neora River	Subtropical mixed broadleaf forest -lower temperate evergreen forest -upper temperate mixed broadleaf forest **Flora** Rhododendron bamboo, Oak, Ferns, Sal **Fauna** Indian leopard, Asiatic black bear, Sloth bear, Asian golden cat
Gorumara Located in the dooars region of jalpaiguri district	Jaldhaka River, Murti River, Raidak River	Tropical deciduous forest **Flora** Sal, Simul, Teak, Siris, Khair **Fauna** Indian rhinoceros, Gaur, Asian elephant, Sloth bear, Chital, Sambar deer
Buxa Lies in alipurduar sub-division of jalpaiguri district	Sankosh, Raidak, Jayanti, Churnia, Turturi, Phashkhawa, Dima, Nonani	Tropical Dry deciduous Forest **Flora** Sal, Champ, Gamar, Simul, Chikrasi **Fauna** Chinese Pangolin, Elephant, Gaur, Sambar, Spotted deer, Barking deer, Hog deer
Khangchendzonga Located at the heart of the himalayan range in northern india	Rathong Chu, Prek Chu	Temperate broadleaf and mixed forest, Krummholz (stunted forest) **Flora** Oaks, Fir, Birch, Maple, Willow, Alpine grasses **Fauna** Musk deer, Himalayan Tahr, Snow leopard, Sloth bear, Red panda, Tibetan wild ass Civet, Himalayan black bear, Himalayan blue sheep



HAL PRADESH

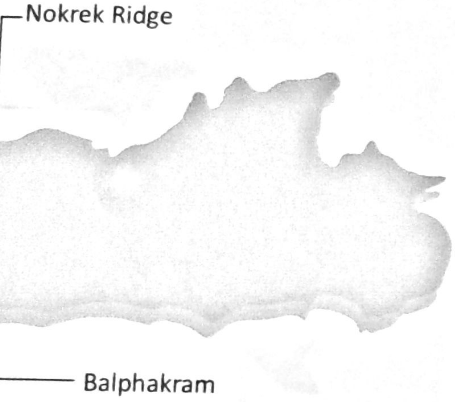


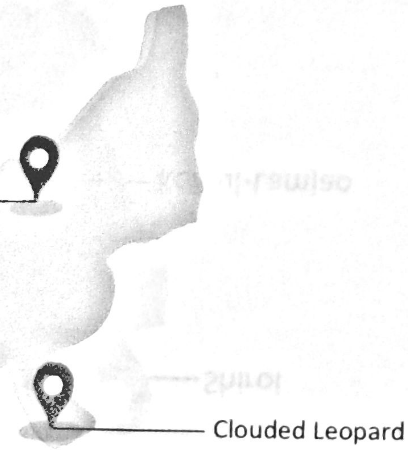


Name and Location	River System	Vegetation Type; Flora and Fauna
Namdapha Located in changlang district, near to international border of myanmar	Noa River, Dihing river	Deciduous forest **Flora** Hollock, hallong, Mekai, Oak, Pine, Betula **Fauna** Tiger, Leopard, Snow leopard, Clouded leopard
Mouling Lies in the international border between india and myanmar (burma) within changlang district	Siang River	Temperate alpine and coniferous forest, Tropical evergreen forest **Flora** Pine, Foxtail, Orchids **Fauna** Bengal Tiger, Takins, Snowcloud leopard, Golden languor, Hornbill, Monal scalater, Serrow
Kaziranga Located in golaghat and nagaon, in the karbi anglong district	Brahmaputra River	Tropical moist broadleaf forests **Flora** Albizia procera, Duabanga grandiflora, *Lagerstroemia speciosa* **Fauna** One Horned Rhino, Elephant, Royal Bengal tiger, Asiatic Water Buffalo, Swamp Deer
Manas Located in two districts bongaigaon and barpeta, at the foothills of the himalayas, this park is contiguous with the royal manas national park in bhutan.	Manas River	Alluvial grasslands, Dry deciduous, Moist deciduous, Semi-evergreen forests **Flora** Formosum, Syzygium Cumini, Cinnamomum Tamala **Fauna** Pygmy Hog, Golden Langur, Indian Rhinoceros, Asiatic Buffalo
Orang Located in udalguri & sonitpur district	Brahmaputra River, Pachnoi River, Dhansiri River	Moist deciduous forest **Flora** Dalbergia sissoo, Sterculia villosa **Fauna** Great Indian rhinoceros, Pygmy hog, Asian elephant, Wild water buffalo, Bengal tiger

Name and Location	River System	Vegetation Type, Flora and Fauna
Dibru-saikhowa Located in the tinsukia district of upper assam	Brahmaputra River, Lohit River, Dibru River	Semi-evergreen forests, Deciduous forest, Littoral and swamp forests, Patches of wet evergreen forests **Flora** Dillenia indica, Bischofia javanica, Bombax ceiba, Mesua ferrea **Fauna** White-winged wood duck, Water buffalo, Black-breasted parrotbill, Tiger, Capped langur
Nameri *Located in the foothills of the eastern himalayas in the sonitpur district*	Jia-Bhoreli, Bor-Dikorai	Tropical Evergreen and Semi-evergreen forest **Flora** Ajar, Urium poma, Bhelu, Agaru **Fauna** Bengal tiger, Indian leopard, Clouded leopard, Marbled cat, Leopard cat, Hog deer, Sambar, Dhole, Gaur, Barking deer
Dihing-patkai *Located in the dibrugarh and tinsukia districts*	Dehing River	Deciduous Rain forest & semi evergreen forest **Flora** Hollong, Mekai, Dhuna, Uriyam, Nahar **Fauna** Royal Bengal tigers, Indian elephants, Himalayan black bears, Hoolock Gibbons, Slow Loris, Capped Langurs, Clouded leopards Porcupines, Marbled cat
Raimona *Located in gossaigaon subdivision of kokrajhar district*	Sarabhanga, Sonkosh	Moist deciduous and semi-evergreen forest **Flora** Poaceae, Rubiaceae **Fauna** Tiger, Leopard, Clouded Leopard, Leopard cat, Golden Cat, Jungle cat, Marbled cat

Name and Location	River System	Vegetation Type; Flora and Fauna
Keibul- lamjao Located in the bishnupur district , which has loktak lake	Khordak River	Moist semi–evergreen forests **FLORA** Tripidium bengalense, Alpinia galanga, Eichhornia crassipes -Hedychium coronarium, Nelumbo nucifera **FAUNA** Brow Antlered Deer or the dancing deer, Hog Deer, Wild Boar, Large Indian Civets, Fox, Jungle Cat, Golden Cat, Bay Bamboo Rat, Musk Shrew, Common Shrew, Flying Fox
Shiroi Located exactly on the indo-myanmar border in imphal district	Moyar River	Dense tropical forest, Temperate Forest in upper Hills **Flora** Sirohi flower species **Fauna** Wild Boar, Tragopan, Leopard, Deer, Tiger
Intanki Located in the peren district	Dhansiri River	Equatorial forests **Flora** Mahogany Trees, Orchids, Bamboo **Fauna** Hoolock gibbon, Golden langur, Hornbill, Asian palm civet, Black stork, Tiger -White-breasted kingfisher -Monitor lizard -Sloth bear
Phawngpui Located in the lawngtlai district, towards the southeast	Chhimtuipui River	Sub-tropical broadleaf and tropical evergreen forest **Flora** Grasses, Orchids, Oak trees, Bamboo groves, The daphnia flower **Fauna** Blyth's tragopan, Hume's pheasant, Dark-rumped swift, Asiatic black bear, Slow loris, Stump-tailed macaque, Tiger, Goral, Capped langur





Name and Location	River System	Vegetation Type, Flora and Fauna
Murlen Lies in the champhai district		Tropical semi-evergreen and sub montane forest **Flora** Quercus, Schima wallichii, Betula, Michelia champaca, Pinus kesiya, Prunus, Myrica, Rhododendron **Fauna** Tiger, Leopard, Himalayan Black bear, Serrow, Hollock Gibbon, Sambar Barking Deer, Wild Boar, Rhesus Macaque, Malayan Giant Squirrel
Nokrek Ridge Located in west garo hills	Dareng River, Ganol River	Tropical evergreen and semi-evergreen deciduous forest **Flora** Bombax ceiba (Cotton tree), Sterculia villosa, Cassia fistula **Fauna** Red Panda, Asiatic elephant, Small marbled cat, Tiger, Clouded leopard
Balpakram Located in south garo hills	Simsang River	Subtropical grassland, Tropical deciduous Forest **Flora** Pitcher Plant, Bamboo Forest, Dosera **Fauna** Indian elephant, Chital deer, Wild water buffalo, Red panda, Bengal tiger, Marbled cat
Clouded leopard Lies within the sepahijala wildlife sanctuary in agartala		Tropical rainforest **Flora** Kanak, Arjuna, Bahera **Fauna** Clouded leopard, Leopard cat, Hoolock gibbon
Bison (rajbari) Located in the trishna wildlife sanctuary		Deciduous with a mixed moist climate, Tropical semi-evergreen, Savannah **Flora** Tulsi, Rudraksha, Kalmegh **Fauna** Indian Gaur, Bisson, Gibbon, Indian Black drongo, Tailorbird

Report/Indices	Published by/ Released by	About	Latest Findings
Climate Change Performance Index (CCPI), 2023 (Released at COP 27 in November 2022)	Germanwatch, New Climate Institute and Climate Action Network (CAN)	• It aims to enhance transparency in international climate politics and enables comparison of climate protection efforts and progress made by individual countries. • Published annually since 2005, it is an independent monitoring tool for tracking the climate protection performance of 59 countries and the EU.	• India's Rank- **8th** • Top Rank- **Denmark, Sweden, Chile and Morocco** as the only four small countries that were ranked above India as 4th, 5th, 6th and 7th respectively. • **Note:** The first, second and third ranks were not awarded to any country.
Global Climate Risk 2020 report	Germanwatch	• The Index analyses the extent to which countries and regions have been affected by the impacts of weather-related loss events (storms, floods, heat waves etc.).	• Mozambique, Zimbabwe as well as the Bahamas were the most affected countries in 2019. • India ranked 7th. • For the period from 2000 to 2019, Puerto Rico, Myanmar and Haiti rank highest.
Environment Performance Index, 2022 (Biennial Index)	World Economic Forum, Yale Centre for Environmental Law and Policy and the Columbia University Centre for International Earth Science Information Network.	• The EPI ranks 180 nations using 40 performance indicators across 11 issue areas on the following policy objectives: climate change performance environmental health ecosystem vitality • These indicators reflect how near countries are to meeting stated environmental policy objectives on a national basis.	• India Rank- **Lowest** among 180 Countries after Vietnam (178), Bangladesh (177), and Pakistan (176). • Overall Score of India- **18.9** Top 3 Countries: 1. Denmark 2. United Kingdom 3. Finland
Energy Transition Index 2021	World Economic Forum	• It checks energy system related data.	India Rank- 87th Top Rank- 1. Sweden 2. Norway 3. Denmark

Report/Indices	Published by/ Released by	About	Latest Findings
"Fostering Effective Energy Transition" Report	World Economic Forum	• Report uses 'Energy Transition Index' to benchmark countries' energy transition progress annually on the three dimensions of energy triangle and the enabling dimensions for transition.	Energy transition not keeping pace with growing climate urgency with challenges compounded by risks to energy security, sustainability, and affordable access. Lack of access to an affordable energy supply has emerged as a key threat to a just transition. Industrial activity generates more than 30% of anthropogenic emissions with 5 heavy industries representing 80% of industrial emission. Dual diversification (of supply source and supply mix) is key to strengthening countries' energy security. **India's Position** • Power Sector has achieved 100 GW of installed • Renewable Energy Capacity. • India has already achieved emission reduction of 28% over 2005 levels, against the target of 35% by 2030 committed in its NDC
Global Energy Architecture Performance Index Report	World Economic Forum	• It is a composite index that focuses on tracking specific indicators to measure the energy system performance of 127 countries.	
BiodiverCities by 2030: Transforming cities' relationship with nature	World Economic Forum	• This report provides a vision for cities of the future and the needed systemic shifts to develop BiodiverCities that place nature at the heart of decision-making and infrastructure investments.	
World Energy Trilemma Index, 2021	World Energy Council.	• It ranks countries on their ability to provide sustainable energy through 3 dimensions: Energy security, Energy equity (accessibility and affordability), Environmental sustainability.	India rank- 75th Top Rank 1. Sweden 2. Switzerland 3. Denmark

Report/Indices	Published by/ Released by	About	Latest Findings
World Energy Outlook	International Energy Agency	• It provides strategic insight on the future of energy and energy-related emissions, and detailed scenarios that map out the consequences of different energy policy and investment choices.	• World is in the midst of the first global energy crisis, triggered by Russia's invasion of Ukraine. • India is likely to see world's biggest rise in energy demand this decade, with demand climbing 3 per cent annually. • Outlook projects continued expansion in coal generation (in absolute terms) in India, peaking around 2030.
Break Through Agenda Report 2022	International Energy Agency, the International Renewable Energy Agency and the UN Climate Change High-Level Champions.	• This is a first-of-its-kind annual progress report, requested at the UN Climate Change Conference COP26 in November 2021 as part of the launch of the Breakthrough Agenda (BA).	
Renewable Energy Report 2022	International Energy Agency (IEA).		• RE will comprise 90 percent of global electricity capacity expansion in next five years and much of it will be in India. • RE's installed power capacity addition will grow to 2,400 gigawatts (GW) between 2022 and 2027. • With addition of 145 GW, India is forecast to almost double its renewable power capacity over 2022-2027.
World Climate and Security Report	International Military Council on Climate and Security (IMCCS)	The report reveals that there are high operational costs of continued fossil fuel use by militaries, and recommends that security leaders across NATO and the EU seize opportunities to ensure that low carbon considerations and energy efficiency standards are key factors in new procurement processes, research and innovation.	

Report/Indices	Published by/ Released by	About	Latest Findings
Adaptation Gap Report 2022- **"Too Little, Too Slow – Climate adaptation failure puts world at risk"**	UN Environment Programme (UNEP)		• More than 8 out of 10 countries (84% of Parties to the UNFCCC) have at least one national adaptation planning instrument. • More than a third of all 198 Parties to the UNFCCC have incorporated quantified and time-bound adaptation targets. • Nearly 90% of planning instruments analysed display consideration for gender and/or historically disadvantaged groups, such as indigenous peoples. • Combined adaptation and mitigation finance flows in 2020 fell at least US$17 billion short of the US$100 billion pledged to developing countries. • Adaptation finance gap in developing countries is likely 5 to 10 times greater than current international adaptation finance flows.
Emission Gap Report 2022	UN Environment Programme (UNEP)	• It assesses the emission gap i.e., the gap between the pledges taken by different countries to reduce greenhouse gas emissions and the estimated reduction required to maintain the average global temperature rise to below 2°C, preferably 1.5°C, by the end of this century.	• To get on track for limiting global warming to below 2.0°C and 1.5°C, global greenhouse gas (GHG) emissions must be reduced by 30% and 45% respectively, compared with current policy projections. • Policies currently in place with no additional action are projected to result in global warming of 2.8°C over the twenty-first century. • World average per capita GHG emissions were 6.3 tons of CO2 equivalent (tCO2e) in 2020. • Total global greenhouse gas emission in 2019 was 58.5 gigatonnes of CO2 equivalent. • For India, per capita emission remains far below the world average at 2.4 tCO2e. • The bottom 50% of households contribute 12% of the global total GHG emissions, whereas the top 1% emit contribute 17% of the total. • India is the 3rd largest GHG emitter. • 1.China • 2. USA • Getting on track to achieve 2030 targets will require an enormous acceleration in effort like Phasing out coal power generation 6 times faster.

Report/Indices	Published by/ Released by	About	Latest Findings
7th Global Environment Outlook (GEO) ,2022	UN Environment Programme (UNEP)	- This report brings the attention of the nation towards environment related problems.	- Current policies cannot keep pace with the rate of environmental degradation we face today. - With current policies none of the environmental SDGs will be achieved and none of the main internationally agreed environmental goals (e.g. Paris Agreement, Aichi Targets, etc.) will be achieved. - Because of this we face a triple planetary crisis of climate change, biodiversity loss and pollution. - Policies which address the systems that are the root cause of environmental degradation should contribute to the transformational change needed to achieve an environmentally sustainable world by 2050.
Actions on Air Quality	UN Environment Programme (UNEP)	This global report provides a review of policy actions of Member States per the mandate provided by UNEA Resolution 3/8 on Preventing and reducing air pollution to improve air quality globally.	
Inclusive Wealth Report	UN Environment Programme (UNEP)	It tracks progress on sustainability of economy and wellbeing of people across the world.	
Food Waste Index	UN Environment Programme (UNEP)	It aims at supporting the goals of SDG 12.3. It does so by presenting the most comprehensive food waste data collection, analysis and modelling to date, generating a new estimate of global food waste; and publishing a methodology for countries to measure food waste, at household, food service and retail level, to track national progress towards 2030 and to report on SDG 12.3.	
Global Methane Assessment Report	UN Environment Programme (UNEP)	The assessment highlights the critical role that cutting methane emissions, including from the fossil fuel industry, plays in slowing the rate of global warming. Cutting human-caused methane by 45% this decade would keep warming beneath a threshold agreed by world leaders.	

Report/Indices	Published by/ Released by	About	Latest Findings
Protected Planet Report 2020	UN Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC) and IUCN	• It is a biennial landmark publication that assess the state of protected and conserved areas around the world.	
The Rise of Environmental Crime Report	UNEP & INTERPOL	• The report recommends the world to come together to take strong national and international action to combat environmental crime.	
State of Finance for Nature (SFN) 2022	UN Environment Programme (UNEP) and the BMZ-financed Economics of Land Degradation (ELD) Initiative with support from Vivid Economics by McKinsey	• It quantifies public and private finance flows to nature-based solutions (NbS) to tackle global challenges related to biodiversity loss, land degradation and climate change.	The nature-based solutions are still significantly under-financed. It indicated that annual investments in nature-based solutions will have to triple by 2030 and increase four-fold by 2050 from the current investments into nature-based solutions of USD 133 billion (using 2020 as the base year).
Nationally Determined Contributions (NDC) Synthesis Report, 2022	UNFCCC	• It is an annual summary of climate commitments made by countries and their impact on global greenhouse gas (GHG) emissions. • These commitments, known as NDCs, were made by countries who signed on to the Paris Agreement to address climate change. • The report analysed NDCs of 193 Parties to the Paris Agreement, including 24 updated or new NDCs submitted after COP 26 (Glasgow).	• Countries are bending the curve of global greenhouse gas emissions downward but these efforts remain insufficient to limit global temperature rise to 1.5 degrees Celsius by the end of the century. • Cumulative CO2 emissions in 2020-2030 would likely use up 86% of the remaining carbon budget. • Combined climate pledges could put the world on track for about 2.5°C of temperature rise by 2100, from a possible range of 2.1°C to 2.9°C.
Global Methane Assessment: 2030 Baseline Report	Climate and Clean Air Coalition (CCAC) and United Nations Environment Programme (UNEP).	• Report was launched at Climate and Clean Air Ministerial Meeting at **27th Conference of Parties (COP27)** to United Nations Framework Convention on Climate Change (UNFCCC). • Report examines baseline projections of methane emissions over the coming decade and implications for Global Methane Pledge (GMP) target.	**Key findings** • In the atmosphere, the amount of Methane is 260% of pre-industrial levels. • Human-led methane emissions are responsible for around 45% of current net warming. • The year 2021 witnessed the largest annual increase.

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State of the Climate in Asia 2021 Report	World Meteorological Organization.		• Economic losses from consequent extreme weather events like floods and droughts amounted to more than US$ 35 billion in 2021. • India suffered an economic loss of $4.4 billion due to storms, and an additional $3.2 billion due to flooding.
State of the Global Climate in 2022 Report	World Meteorological Organization	• This annual report provides details of climate indicators such as temperatures, ocean heat, ocean acidification, sea level rise, sea ice glaciers and extreme weather.	• Carbon dioxide rose by 149%, Methane 262% and Nitrous oxide 24% of pre-industrial levels. • Increasing emissions of CO2 and GHGs cause a positive radiative imbalance at the top of the atmosphere. • Last 8 years are likely to be the 8 warmest years on record. • It is about 1.15oC above the 1850- 1900 pre-industrial average. 55% of the ocean surface experienced at least one Marine heatwaves during 2022. • Oceans store around 90% of the accumulated heat from human emissions of greenhouse gases. • Greenland Ice Sheet ended with a negative total mass balance for the 26th year in a row.
Greenhouse Gas Bulletin 2022 (Annual report)	World Meteorological Organization (WMO).		• Atmospheric levels of the 3 main greenhouse gases warming our planet - carbon dioxide,methane and nitrous oxide- all reached new record highs in 2021. • This is the result of both biological and human induced processes. • Emissions will also increase by 10.6% by 2030 from 2010 levels.
Global Ocean Observing System (GOOS) Report Card, 2022.	World Meteorological Organisation	• It highlighted biological observations for the first time and identified gap in system. • It pointed at inequality in operational services across oceans like Indian, Atlantic and Southern Ocean.	• Oceans take up 26% of 40 gigatons of carbon emitted to atmosphere annually (48% remains in atmosphere while terrestrial biosphere takes rest). • Only 5% cent of platforms at sea carry biogeochemical sensor, including carbon dioxide sensors. • Argo profiling float array is providing 15% less data as compared to pre-pandemic. • Inequality in operational services across oceans like Indian, Atlantic • and Southern Ocean have been observed.

Report/Indices	Published by/ Released by	About	Latest Findings
Provisional State of The Global Climate in 2022 Report	World Meteorological Organisation (WMO)		**Key Findings** ● The past eight years are on track to be the eight warmest on record. ● The rate of sea level rise has doubled since 1993. ● It has risen by nearly 10 mm since January 2020 to a new record high this year. ● The past two and a half years alone account for 10 percent of the overall rise in sea level since satellite measurements started nearly 30 years ago. ● The global mean temperature in 2022 is currently estimated to be about 1.15 [1.02 to 1.28] °C above the 1850-1900 pre-industrial average ● The 10-year average for the period 2013-2022 is estimated to be 1.14 [1.02 to 1.27] °C above the 1850-1900 pre-industrial baseline. ● Ocean heat was at record levels in 2021 with the warming rate particularly high in the past 20 years.
State of Climate Services 2022	World Meteorological Organisation (WMO)	● It focuses on energy year because it holds the key to international agreements on sustainable development and climate change and, indeed, to the planet's health.	● It highlights the huge opportunities for green-powered grids to help tackle climate change, improve air quality, conserve water resources, protect the environment, create jobs and safeguard a better future for us all.

Report/Indices	Published by/ Released by	About	Latest Findings
State of The Climate in Asia 2021 Report	World Meteorological Organisation (WMO)		**Key Findings** • Economic damage from drought has increased by 63 percent from flood has increased by 23 percent, and from landslides has increased by 147 percent compared to the 2001-2020 average. • Economic losses from drought, floods and landslides have rocketed in Asia. • In 2021 alone, weather and water-related hazards caused total damage of US$ 35.6 billion, affecting nearly 50 million people. • High Mountain Asia, including the Himalayas and the Tibetan Plateau, contains the largest volume of ice outside of the polar region. • The rate of glacier retreat is accelerating and many glaciers suffered from intense mass losses as the result of exceptionally warm and dry conditions in 2021. • In 2021, flooding caused the highest economic losses in China (US$ 18.4 billion), followed by India (US$ 3.2 billion), and Thailand (US$ 0.6 billion). • Storms also caused significant economic damage, especially in India (US$ 4.4 billion), China (US$ 3.0 billion), and Japan (US$ 2 billion).
Climate Change and Land	Intergovernmental Panel on Climate Change (IPCC)	• The report is a special report by IPCC which complement the main Assessment Reports that the IPCC publishes every five or six years.	The report explains how land-based activities such as agriculture, forestry, cattle-rearing and urbanisation are causing global warming, and is affected by climate change.
Global Futures Report	World Wide Fund for Nature, Global Trade Analysis Project and the Natural Capital Project	• The report analysed how the natural assets would change under various future development scenarios and how the consequent changes in ecosystem services would in turn affect the global economy	
Nature risk rising report	World Economic Forum (WEF) in collaboration with PwC	• It explains how nature-related risks matter to business, why they must be urgently mainstreamed into risk management strategies	

Report/Indices	Published by/ Released by	About	Latest Findings
Restoration Barometer Report, 2022 (First Report)	International Union for Conservation of Nature (IUCN)	• This report documents financial investments of $26 billion across 18 countries and 14 million hectares of degraded landscapes. • It records the size of the area being brought under restoration as well as the corresponding climate, biodiversity and socio-economic benefits, and covers the enabling policies and funding structures at the heart of successful restoration.	• Currently, 22 countries are using the Barometer to report the progress of their restoration targets and more than 50 have endorsed it. • The report documents financial investments of $26 billion across 18 countries and 14 million hectares of degraded landscapes. • Data from Ecuador, India, Pakistan, and Uzbekistan is being finalized and will be published later.
World Heritage Glaciers Report	UNESCO and IUCN		• A third of Glaciers among the World Heritage sites will disappear by 2050. • Glaciers have been identified in 50 sites on the UNESCO World Heritage List. • Around 18,600 glaciers have been identified in these sites, representing almost 10% of the Earth's glaciered area. • They have been retreating at an accelerated rate since 2000 due to rising CO2 emissions. • If emissions are drastically cut to limit global warming to 1.5°C relative to preindustrial levels, glaciers in two-thirds of World Heritage sites could be saved.
Climate Investment Opportunities in India's Cooling Sector	World Bank		**Key Findings of the Report** • From 2030 onwards, more than 160 to 200 million people could be exposed to a lethal heat wave in India every year. • Around 34 million Indians will face job losses due to heat stress-related productivity decline. • By 2037, the demand for cooling is likely to be 8 times more than the current level. • Market potential and investment opportunity in space cooling will be US$1.6 trillion by 2040., besides reducing greenhouse gas emissions significantly and creating 3.7 million jobs.
Regulatory Indicators for Sustainable Energy (RISE)	World Bank	• It assesses countries' policy and regulatory support for each of the three pillars of sustainable energy—access to modern energy, energy efficiency, and renewable energy.	

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Polluted River Stretches for Restoration of Water Quality Report 2022	Central Pollution Control Board (CPCB)	- It assesses water quality for identification of polluted river stretches.	**Key findings of report** - The number of polluted stretches in India's rivers has fallen from 351 in 2018 to 311 in 2022. - The number of polluted river stretches categorized in 'Priority I & II' is almost unchanged. - Maharashtra has highest number of PRS followed by Madhya Pradesh. - Biological Oxygen Demand (BOD) exceeding 3.0 mg/L (milligram per litre) is identified as a polluted location. - Out of 1920 locations on rivers monitored during 2019 & 2021, 1103 locations (57%) were observed complying with BOD criteria of less than 3.0 mg/L, notified for Outdoor bathing. - Significant reduction in number of PRS is observed in Priority V.
State of the World's Forests 2022 (SOFO 2022)	United Nations Food and Agriculture Organization (FAO)	- It explores the potential of three forest pathways for achieving green recovery and tackling environmental crises, including climate change and biodiversity loss.	- Forests provide habitat for 80% of amphibian species, 75% of bird species and 68% of mammal species, and tropical forests contain about 60% of all vascular plant species. - 420 million ha of forest lost through deforestation between 1990 and 2020. - About 33 million people – 1% of global employment – are estimated to work directly in the formal and informal forest sector - COVID-19 pandemic may have longer-term impacts on woodfuel, having pushed an estimated 124 million more people into extreme poverty. - More than half (54%) of the world's forests is found only in five countries – **Russian Federation, Brazil, Canada, the United States of America and China.**

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State of the World's Birds	: BirdLife International		• Populations of almost half of all bird species are declining globally because of human influenced factors. • Around 48% of bird species worldwide are known or suspected to be undergoing population declines. • Avian diversity peaks globally in the tropics, and it is there that they also find the highest richness of threatened species • World is now witnessing the first signs of a new wave of extinctions of continentally distributed bird species, which has followed the historic loss of species on islands like the Dodo. • Endemic species, birds of prey, and those dwelling in forests and grasslands were the most threatened.
Investing in carbon neutrality: Utopia or the new green wave?	UN Food and Agriculture Organization (FAO) and European Bank for Reconstruction and Development (EBRD)	It provides a comprehensive report at decarbonizing agrifood systems.	• Emissions from agrifood systems account for 21 to 37 percent of total anthropogenic greenhouse gas emissions. • It focuses on: • removing emissions across entire supply chains – from farm to fork. • more efficient farming practices and sustainable agriculture, • use of agricultural lands for carbon sequestration, • avoidance of land clearing, • efficient processing and logistics, • reduction of food loss and waste, including at consumer level.
Arctic Report Card 2022	US National Oceanic and Atmospheric Administration (NOAA).	• Issued annually since 2006, it is a peer-reviewed source that provides up-to-date environmental information on Arctic.	• Arctic continues to warm more than twice as fast as rest of globe India in Arctic • Since 2007, India has an Arctic research programme with several expeditions undertaken till date. • India also unveiled its first Arctic policy. • India is one of the Observers in the Arctic Council.
State Energy & Climate Index (SECI)-Round I	NITI Aayog	It is the first index that aims to track the efforts made by states and union territories (UTs) in the climate and energy sector.	• It ranks the States based on their efforts towards improving energy access, energy consumption, energy efficiency, and safeguarding environment. • Top 3 performers based on classification 1. **Larger States:** Gujarat, Kerala, and Punjab. 2. **Smaller States:** Goa, Tripura, and Manipur. 3. **UTs:** Chandigarh, Delhi, and Daman & Diu/Dadra & Nagar Haveli.

Report/Indices	Released by		
Dynamic Ground Water Resource Assessment Report, 2022.	Union Minister of Jal Shakti	• The assessment was carried out jointly by Central Ground Water Board (CGWB) and States/UT.	• The total annual groundwater recharge for the entire country has been assessed as 437.60 billion cubic meters (bcm). From which, 8% as total natural discharges and 92% as annual extractable groundwater resources. • Groundwater extraction in India is currently at 60%. • The overall contribution of rainfall recharge to the country's total annual groundwater recharge is 61 % and the share of recharge from 'Other sources' is 39 %. • Overall decrease in the number of over-exploited areas has been observed as compared with 2017 report.
State of Global Water Resources Report	World Meteorological Organization (WMO)	• It assesses the effects of climate, environmental and societal change on the Earth's water resources. • It aims to support the monitoring and management of global freshwater resources in an era of growing demand and limited supplies. The report focuses on • **Streamflow** – the volume of water in a river channel at any given time. • **Terrestrial water storage** - all water on the land surface and sub-surface. • **The cryosphere** -frozen water.	• Currently, 3.6 billion people face inadequate access to water at least a month per year, which is expected to increase to more than 5 billion by 2050. • Between 2001 and 2018, 74% of all-natural disasters were water-related. • Large areas recorded drier than normal conditions in 2021 due to climate change and the La Niña event. • The annual glacier run-off typically increases at first, until a turning point, often called "peak water", is reached, upon which run-off declines.
EnviStats-India 2022	National Statistics Office (NSO)	• Environment statistics aims at providing statistical information to improve knowledge of the environment.	
Global Carbon Budget 2022 Report	Global Carbon Project (GCP)	• It aims to develop a complete picture of the global carbon cycle.	• Global CO2 concentrations set new record of 417.2 parts per million. • Atmospheric CO2 concentrations are now 51% above pre-industrial levels. • Projected CO2 emissions decrease in China and European Union, but increase in US, India (6%), and rest of world.

Report/Indices	Published by/ Released by	About	Latest Findings
Climate Transparency Report	Partnership of climate analysis organisations in G20 countries.	- The CTR provides a concise overview on the state of climate performance of the G20.	- Six G20 members including India did not sign the global methane pledge. - At 1.5°C, most G20 members can expect water scarcity and prolonged periods of drought, and less favorable agricultural conditions. - India lost 5.4% of its gross domestic product, in the service, manufacturing, agriculture, and construction sectors due to extreme heat in 2021. - Several areas of Hindukush Karakoram Himalaya, experienced reduced snowfall and glacial retreat. - Local precipitation is projected to increase 5.8% and labour productivity is projected to decline by 5% from the reference period of 1986-2006 at 1.5°C of warming.
The Coldest Year of The Rest of Their Lives Report	United Nations Children's Fund (UNICEF).	- It shows that nearly all the children across the world will be exposed to more frequent and severe heat waves by 2050.	- Around 624 million children are exposed to one of three other high heat measures- high heatwave duration, high heatwave severity or extreme high temperatures. - One in four children lives in areas where the average heatwave event lasts 4.7 days or longer as of 2020. - Virtually every child on earth will face severe heatwaves even with an estimated 1.7 degrees Celsius of warming in 2050.
State of Climate Action Report 2022	Climate Action Tracker (an independent analytic group comprising Climate Analytics and New Climate Institute), the United Nations High-Level Climate Change Champions, World Resources Institute and others.	- It provides a comprehensive assessment of the global gap in climate action across the world's highest emitting systems.	- Total global greenhouse gas emission in 2019 was 58.5 gigatonnes of CO2 equivalent. - Getting on track to achieve 2030 targets will require an enormous acceleration in effort like Phasing out coal power generation 6 times faster.

Report/Indices	Published by/ Released by	About	Latest Findings
'The State of the World's Mangroves 2022	Global Mangrove Alliance	• It focuses on Mangroves spread in India.	• The total mangrove cover in India was 4,992 sq km, an increase of 17 sq Km as compared to 2019. • Top 5 State/UT with mangrove Cover: West Bengal, Gujarat, Andaman and Nicobar Islands, Andhra Pradesh and Maharashtra. • Overall, 12 states/UTs have Mangrove Cover. • Sunderbans, spread across India and Bangladesh, is the largest Mangrove Forest of the world.
United in Science Report 2021	WMO, UNEP etc	• The report is a coordination of WMO, United Nations Environment Programme, World Health Organization, Intergovernmental Panel on Climate Change, Global Carbon Project, World Climate Research Programme and the Met Office (UK).	• Global fossil carbon dioxide (CO2) emissions in 2021 returned to pre-pandemic levels of 2019. • 2015 to 2021 were the warmest on record. • Climate change made extreme heat and floods worse in 2022. • By 2050, at least 1.6 billion people around the world will be regularly exposed to 3-month average temperatures reaching at least 35°C.
Renewable Energy (RE) and Jobs Annual Review 2022 Report	International Renewable Energy Agency (IRENA) and the International Labour Organization	• The report identified domestic market size, along with labor, as a major factor influencing job growth in the sector.	India related findings • Reaching India's goal of 500 GW of non-fossil-fuel energy sources by 2030 could create 3.4 million new job opportunities. • India accounted for about 18% of global hydropower employment, followed by Brazil. Other Key findings • RE sector employed 12.7 million people across the world in 2021. • Solar energy was found to be the fastest-growing sector. • The share of women in the Decentralised Renewable Energy (DRE) workforce is still low,particularly for skilled jobs.
Guiding Principles for Children on the Move in the Context of Climate Change	United Nations Children's Fund (UNICEF) and International Organization for Migration (IOM)	• It highlights the relevance and application of each principle for children who move specifically in the context of climate change ..	• In 2020, nearly 10 million children were displaced due to weather-related events. • Nearly 90% of the global burden of disease associated with climate change is borne by children under the age of five. • India is among 4 South Asian countries where children are most at risk of the impacts of climate change as per UNICEF's Children's Climate Risk Index' (CCRI).
Aridity Anomaly Outlook Index	India Meteorological Department (IMD)	• It focuses on aridity or dryness.	• Only 63 of 756 districts were non-arid, while 660 were facing different degrees of aridity — mild, moderate and severe. • Some 196 districts are facing a 'severe' degree of dryness and 65 of these are in Uttar Pradesh. • Bihar had the second highest number of districts (33) experiencing arid conditions.

Report/Indices	Published by/ Released by	About	Latest Findings
Asia Pacific Sustainability Index 2021	Knight Frank	• The Index rated 36 cities based on urbanisation pressure, climate risk, carbon emissions and government initiatives.	• Four Indian cities Bengaluru (being top) followed by Delhi, Hyderabad and Mumbai made it to the list of top 20 sustainable cities. • India is the 6th largest country in Asia Pacific in terms of the total amount of green bonds issued in 2021.
Carbon Pricing Leadership Report 2021-22	Secretariat of Carbon Pricing Leadership Coalition (CPLC)	• It reviews global developments in carbon pricing, implications for carbon market growth and broader limitations to carbon pricing potential.	• Less than 4% of global emissions are currently covered by a carbon price within the range needed by 2030 to meet the Paris Agreement temperature goals. • Several countries increased their carbon tax rates and adopted more ambitious trajectories, and pilot ETS are being considered in a number of countries.
Renewables 2022 Global Status Report	REN21	• It brings about different countries initiatives in Renewable energy.	• India added around 15.4 GW of renewable power capacity in 2021, third highest after China (136 GW) and the US (43 GW). • India is now the third-largest market in the world for new solar PV capacity and ranked fourth in the world for total solar energy installations (60.4 GW) following China (305.9 GW). • India ranked 2nd in new Solar Water Heating Capacity addition, 3 rd in Hydropower capacity addition and 5th in Ethanol production addition in 2021. • $24.3 billion was allotted for its solar energy schemes, providing incentives to domestic and international companies to set up battery manufacturing plants.
World Migration Report 2022	UN International Organization for Migration (IOM)	• The report highlights that more people are being displaced by changing climate related disasters than conflicts and violence. • This report is prepared every second year.	• In 2020, 144 countries reported new displacement due to disasters, while 42 countries reported displacement due to Conflicts. • By the end of 2020, there were 26.4 million refugees globally. • The highest number of refugees (8 million) moved from Syria - the fifth biggest source country. • Asia reported the largest displacement due to disasters. • The Philippines experienced the highest absolute numbers of new disaster displacements in 2020. • India reported nearly 4 million new displacements due to disasters.

Report/Indices	Published by/ Released by	About	Latest Findings
World Risk Index 2022	United Nations University Institute for Environment and Human Security (UNU-EHS)	- It ranks countries on their risk of experiencing disaster or vulnerability to extreme natural events such as earthquakes, tsunamis, floods, and drought.	- Philippines, India, and Indonesia have the highest overall disaster risk.
State Energy Efficiency Preparedness Index	NITI Aayog & Bureau of Energy Efficiency	- It examines states' policies and regulations, financing mechanisms, institutional capacity, adoption of energy efficiency and the resultant energy savings achieved.	
Special Report on Sustainable Recovery	NITI Aayog and International Energy Agency	- The report shows that governments have a unique opportunity today to boost economic growth, create millions of new jobs and put global greenhouse gas emissions into structural decline.	
Energy Performance Index	Bureau of Energy Efficiency	- It is the key metric used for benchmarking energy usage in commercial building. - EPI is the energy used per unit area measured as kWh/m2/year or kWh/person/year	
State Rooftop Solar Attractiveness Index (SARAL)	Ministry of Power	- It introduces a measuring scale or an index to evaluate and rank all states according to their performance, growth, level of maturity, policy framework, and implementation environment in the rooftop solar sector.	
Swachh Survekshan Report 2022	Ministry of Housing and Urban Affairs	- Swachh Survekshan has been conducted since 2016 and is the world's largest urban sanitation and cleanliness survey. - It has been instrumental in fostering a spirit of healthy competition among towns and cities to improve their service delivery to citizens and towards creating cleaner cities.	**More than 1 lakh Population:** 1. Indore 2. Surat 3. Navi Mumbai **Less than 1 lakh Population:** 1. Panchgani , Maharashtra 2. Patan , Chhattisgarh 3. Karad , Maharashtra Best Ganga Town: *Haridwar in Uttarakhand* Fast Mover City Award: *Shivamogga in Karnataka.* States with More than 100 Urban Local Bodies: *Madhya Pradesh emerged as the 'Cleanest State', Chattisgarh in second place and third in Maharashtra.*

Report/Indices	Published by/ Released by	About	Latest Findings
National Climate Vulnerability Assessment Report	Department of Science and Technology	- It identifies the most vulnerable states and districts in India with respect to current climate risk and key drivers of vulnerability.	
Status of Leopards, Co-predators and Megaherbivores	Ministry of Environment.	- It gives an official count of Leopards.	
State of India's Environment	Ministry of Environment.	- The report focuses on climate change, migration, health and food systems. It also covers biodiversity, forest and wildlife, energy, industry, habitat, pollution, waste, agriculture and rural development.	
The Forest Declaration Assessment (formerly the New York Declaration on Forests Progress Assessment)	Civil Society	The report shows progress toward the global goals of halting deforestation and restoring 350 million hectares of degraded land by 2030. The goal was set out in international declarations such as the New York Declaration on Forests (2014) and the Glasgow Leaders' Declaration on Forests and Land Use (2021). 1. It is a set of four reports covering different themes: **Overarching forest goals,** 2. **Sustainable production and development,** 3. **Finance for forests, and** 4. **Forest governance.**	**Key Findings** - To be on course to halt deforestation completely by 2030, a 10 percent annual reduction is needed. - Commodity-driven tree cover loss declined by 6 percent in 2021 compared to previous years (2018-20). - Deforestation rates are still higher than in any year before 2016 and are far from the - trajectory (20% reduction per year) needed to reach the 2025 target. - Forest finance cost up to USD 460 billion per year to protect, restore, and enhance forests on a global scale. - With only eight years left to reach the 2030 goals, governance of forests and forest lands is not yet strong enough to curb deforestation and degradation in line with those goals.
Finance for climate action: Scaling up investment for climate and development Report	Independent High-Level Expert Group on Climate Finance (CF)	It provides a framework for finance for climate action, covering the overall needs for the comprehensive approach embodied in the Paris Agreement and UNFCCC.	**Key findings** About \$2tn (£1.75tn) will be needed each year by 2030 to help developing countries cut their greenhouse gas emissions. 90% of total Climate Finance is targeted for mitigation purposes. Most of the Climate Finance which was raised were debt, of which only 16% was low-cost. Most financing remains in its country of origin

Report/Indices	Published by/ Released by	About	Latest Findings
Swachh Vayu Survekshan	Ministry of Environment, Forest and Climate Change	It promotes ranking of 131 cities in the country for implementing City Action Plans prepared as part of National Clean Air Programme (NCAP) for reducing air pollution upto 40% by 2025-26.	
2022 update of its air quality database.	WHO	● It recommends levels and interim targets for common air pollutants: **PM, O3, NO2, and SO2.** ● First released in 1987. ● In 2021, the latest version was published.	● Entire global population breathes air that exceeds WHO air quality limits. ● Introduces for the first time, ground measurements of annual mean concentrations of nitrogen dioxide (NO2), a common urban pollutant and precursor of particulate matter and ozone. ● Includes measurements of particulate matter with diameters equal or smaller than 10 µm (PM10) or 2.5 µm (PM2.5).
State of India's Environment (SoE) in figures, 2022	Centre for Science and Environment		India recorded 280 heatwave days across 16 states in 2022. Himachal Pradesh (HP), Uttarakhand and Jammu & Kashmir have been unusually warm. April was the hottest month for northwest and central India. Rajasthan, MP, HP, Gujarat and Haryana recorded 54 percent of heatwaves.
Global Wind Report 2022(Annual report)	International Energy Agency (IEA)		Global demand for energy is increasing 3 per cent annually. India is likely to see world's biggest rise in energy demand this decade. There will be expansion in coal generation around 2030.

GLOSSARY

- **Acid Shock/Acid Surge**: It refers to a sudden and significant decrease in the pH level of water bodies, typically caused by acid rain or acid mine drainage, which can have harmful effects on aquatic ecosystems and their organisms.
- **Auto shredder fluff:** It is the residual material after recycling cars, containing non-metallic components. Recycling and disposing of it is challenging due to its complex composition. Efforts are focused on finding solutions for extracting valuable materials and minimizing environmental impact.
- **Blue Carbon**: It refers to the carbon captured and stored by coastal and marine ecosystems, such as mangroves, seagrasses, and salt marshes. It plays a crucial role in mitigating climate change by sequestering carbon dioxide from the atmosphere.
- **Biomass co-firing**: It is the practice of substituting a part of the fuel in coal thermal plants with biomass. These biomass pellets are made from wood wastes, agricultural waste, commercial grasses, and forestry residues.
- **Biophages**: Biophages, or bacteriophages, are viruses that specifically infect and replicate within bacteria. They can be used as natural alternatives to antibiotics for treating bacterial infections, as they target and kill specific bacteria while leaving beneficial microbes unharmed.
- **Carbon fertilization effect**: Carbon fertilization effect refers to the phenomenon where increased atmospheric carbon dioxide (CO2) concentrations enhance plant growth and productivity through photosynthesis, potentially leading to increased carbon uptake by vegetation and influencing global carbon cycling.
- **Critical load:** It is the maximum stress a system can handle without suffering significant damage or failure. It is crucial in ensuring the safety and reliability of structures.
- **Carbon Footprint:** It is the total amount of greenhouse gas emissions, primarily carbon dioxide, released directly or indirectly by an individual, organization, or product. It measures the impact of human activities on climate change and is used to assess environmental sustainability.
- **Coral Cryopreservation**: It is the process of freezing and storing coral samples at extremely low temperatures to preserve their genetic diversity and protect against the impacts of climate change and other threats to coral reefs.
- **Climate emergency**: Climate emergency signifies the urgent state of the Earth's climate system, demanding immediate action to address climate change impacts through mitigation, adaptation, and preservation of ecosystems.
- **Cap & Trade**: Cap and trade is a market-based approach to controlling pollution. It sets a limit (cap) on emissions and allows companies to trade emission allowances, incentivizing emission reduction and achieving overall environmental targets.
- **Disclimax**: Also called a disturbance climax community, it occurs at the early stages of ecological successions. They occur due to unpredictable disturbances (by humans and/or domestic animals) that prevent succession from reaching a stable climax community. For example, a grassland community that has been altered to desert by overgrazing.
- **Ecosystem Integrity**: It refers to completeness and functionality of an ecosystem and its ecological processes, particularly in relation to its natural state.
- **Ecological footprint**: Ecological footprint measures the impact of human activities on the environment by quantifying the amount of natural resources consumed and waste produced, helping assess sustainability and resource management.
- **Extinction Vortex**: It is a downward spiral for endangered species with reduced genetic diversity, increased genetic disorders, and heightened risk of

extinction. Conservation measures are necessary to prevent extinction.

- **Flue Gas Desulphurization (FGD)**: The process of eliminating sulphur compounds from the exhaust emissions of fossil-fueled (coal-fired) power plants is known as flue gas desulphurization (FGD).
- **Greenwashing**: It is defined as a growing tendency among firms and governments to label certain activities as climate-friendly, which would lead to emissions reduction, or avoidance of emissions.
- **Krummholz**: It refers to the zone between treeline and more open alpine vegetation and includes stunted and deformed trees.
- **Marine snow**: It refers to the shower of organic particles and detritus that drifts down through the water column in oceans, providing a vital source of food and energy for deep-sea organisms.
- **Precautionary Principle**: It states that if an action or policy has the potential to cause harm to the public or the environment, in the absence of scientific consensus, precautionary measures should be taken to prevent harm.
- **Plasticrust**: It refers to a newly identified type of pollution found on shorelines, where plastic debris mixes with sediment and forms a layer of hardened plastic coating on rocks and other surfaces.
- **Polluter pays principle**: It is an environmental policy concept that suggests that the party responsible for producing pollution should be responsible for covering the costs of its damage to the environment. This principle aims to provide an economic incentive for polluters to reduce their pollution output and shift the costs of pollution control from society to the polluter.
- **Reclaimed water**: Also known as recycled or reused water, it is treated wastewater that has undergone processes to remove impurities and contaminants. It is then used for various non-potable purposes such as irrigation, industrial processes, and groundwater replenishment.
- **Urban Ecology:** It is a field of study that deals with how living organisms (including humans) react with each other and their surroundings in an urban environment.